AUTOMATION

SEPTEMBER 1960

Producing Missile Components

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Basic Controller Fundamentals
- Filling Glass Ampules
- Engineering Costs—Who Pays?
- Applying Building Block Units

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A PENTON PUBLICATION

Ed Weiner, president, talks with Ed Lebowitz, right, Chesterfield's superintendent, by one of the firm's three Wean Equipment slitting lines.

Chesterfield Steel relies on speed, accuracy, durability of Wean coil processing lines

Fast delivery—when, where, and how the customer wants it—is the metal warehouse's stock-in-trade. And Ed Weiner, president of Cleveland's Chesterfield Steel Service Co., is proud of the firm's record for on-time, "on-spec" deliveries of strip and sheet steel, nonferrous and coated metals.

To maintain this reputation for service, Chesterfield needs equipment that will maintain its accuracy under tough, 3-shift, week-long operation. That's why this progressive firm has installed three Wean slitting lines and the 52″ Wean flying shear line shown below . . . and is ordering another flying shear line for 60″ wide strip. Most of the firm's orders for sheet material pass through this coil processing equipment, making both speed and reliability of operation vital. Mr. Weiner notes that the Wean 52″ flying shear line has doubled sheet production over other types of lines previously used by Chesterfield.

Like Chesterfield, Wean has established a reputation as one of the most knowledgeable firms in the field of coil processing and has built equipment that is now serving many of the country's largest metalworking firms. Write for a brochure covering the important savings *you* can realize from coil processing.

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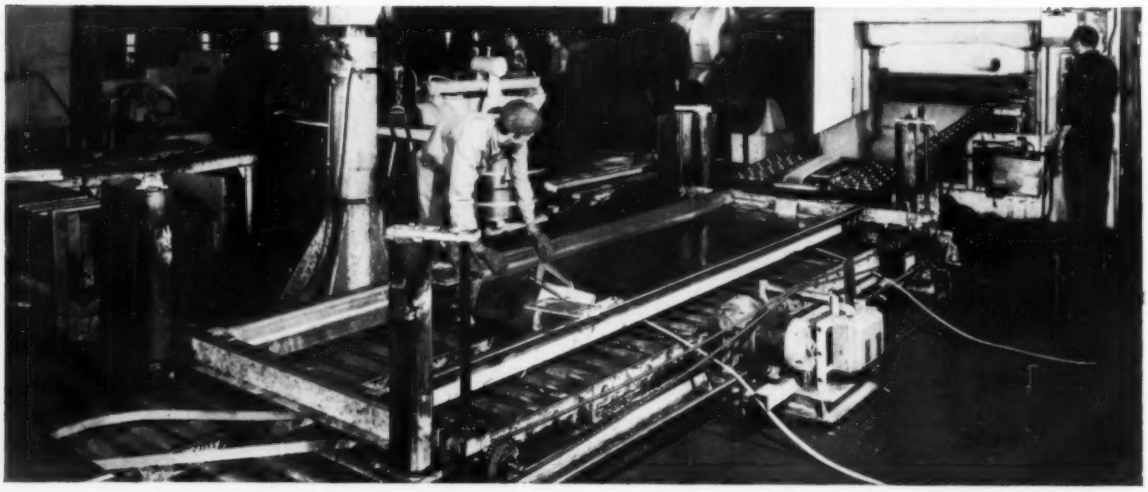
WEAN

Wean flying shear line has elevating run-out conveyor and side guides which adapt to pack height.



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Circle 750 on Page 19

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Vol. 7 — No. 9

AUTOMATION®

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The Magazine of Automatic Manufacturing Operations

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automation outlook

USERS' VIEWS ON ENGINEERING COSTS

". . . the purchaser does pay for engineering costs—but what he pays and when—is influenced greatly by the decisions of people on both the buying and selling side . . . . the most logical action is to take every measure possible to keep engineering costs to a minimum . . . ."—*K. C. Butterfield, staff master mechanic, Corporate Production Engineering Dept., Chrysler Corp., see page 69.*

". . . The customer pays. But how does he pay? When does he pay? And who owns the engineering? . . ."—*W. W. Kuyper, manager, manufacturing engineering, Large Steam Turbine-Generator Dept., General Electric Co., see page 73.*

". . . engineering services are true professional services, and the cost of such services might just as well be recognized as an expensive but, nevertheless, absolutely essential expense cost in operating a manufacturing business . . . ."—*R. L. Schoenberger, manager, equipment engineering and maintenance, R. R. Donnelley & Sons Co., see page 75.*

". . . manufacturing engineering or manufacturing research effort is required to produce new breakthroughs in manufacturing equipment and processes which essentially must be custom-built to meet the requirements of one user. Regardless of whether this effort is expended in-plant or subcontracted, the user must pay, and he is entitled to certain rights, including patent protection . . . ."—*W. A. Stadtler, director, manufacturing research, International Business Machines Corp., see page 77.*

THE FUTURE IN MACHINING

". . . by 1970 we might expect that relative man-hour requirements for machining might once again be reduced to approximately half what they are today. From whence will this further improvement come? One of the factors already beginning to appear on the scene is the possibility of "automatic design"—that is the possibility of starting with merely the basic design specifications as conceived by the engineer, putting those into a computer, and from these deriving in turn the design of a finished part to fulfull these specifications and a program to operate the machine tool to produce this part . . . ."—*M. E. Merchant, director of physical research, Cincinnati Milling Machine Co.*

EXPANDABLE DATA REDUCTION

". . . Data-reduction equipment will play an ever-increasing role in process instrumentation, but I am strongly of the opinion that data-handling equipment should be introduced gradually, rather than by a frontal assault to revolutionize process control instrumentation . . . . Fortunately, data-reduction equipment is now becoming available in small package units, so that any company can experiment with data-reduction on a modest basis. After the advantages of such equipment are established in a given situation, the data handling equipment, usually modular in construction, can be expanded as necessary to fill the need without increasing the risk of over-investment . . . ."—*A. O. Beckman, president, Beckman Instruments Inc.*

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BPA NBP

. . . Fluid Power news

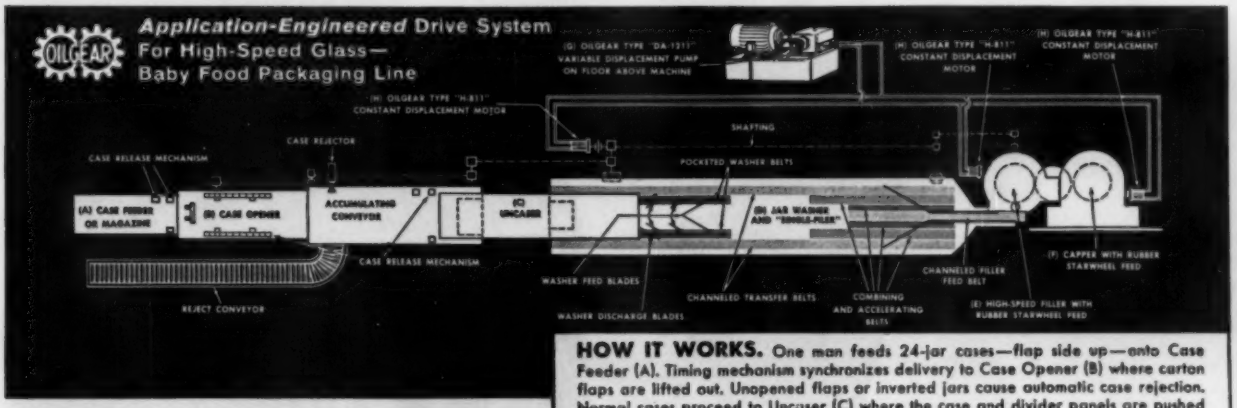
REPORT NO. 11,303 SPEED—COST "BREAK-THRU" FOR GLASS PACKAGING

From Oilgear Application-Engineering Files

HOW OILGEAR SYSTEMS *on Gerber's Integrated Glass Lines* BOOST OUTPUT—CUT COSTS

USER: *Gerber Products Company, Fremont, Michigan; Rochester, New York; Oakland, California*

DATA: To sharply reduce breakage, jam-ups, downtime, and labor costs in filling glass baby food jars at higher speeds, Gerber's Engineering Research Department developed the first fully integrated, high-speed machine for packaging foods in glass economically, under completely automatic control. *Drive Requirements for this multi-unit machine were outlined as follows:* 1. Complete synchronization of the seven integrated units through three drives—at the Uncaser, Filler, Capper. 2. Positive, precise, remote pneumatic control of operating speed that is instantly, infinitely variable from very slow to top speed while the machine is running. 3. Controlled acceleration and deceleration to prevent jars from tipping and jamming, eliminates spillage, reduces machine strain. 4. Compact, for maximum work area. 5. Independent operation of Filler and Capper drives to facilitate cleaning. 6. Trouble-free, dependable, long-life operation, immune to frequent sanitary washdowns, fully enclosed to prevent food contamination.


Application-Engineered Drive System
For High-Speed Glass—
Baby Food Packaging Line
(G) OILGEAR TYPE "DA-1211" VARIABLE DISPLACEMENT PUMP ON FLOOR ABOVE MACHINE
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
SHAFTING
CASE RELEASE MECHANISM
CASE REJECTOR
POCKETED WASHER BELTS
(A) CASE FEEDER OR MAGAZINE
(B) CASE OPENER
ACCUMULATING CONVEYOR
(C) UNCASER
(D) JAR WASHER AND "SINGLE-FILER"
(F) CAPPER WITH RUBBER STARWHEEL FEED
CASE RELEASE MECHANISM
WASHER FEED BLADES
CHANNELED FILLER FEED BELT
CHANNELED TRANSFER BELTS
COMBINING AND ACCELERATING BELTS
(E) HIGH-SPEED FILLER WITH RUBBER STARWHEEL FEED
REJECT CONVEYOR
WASHER DISCHARGE BLADES

HOW IT WORKS. One man feeds 24-jar cases—flap side up—onto Case Feeder (A). Timing mechanism synchronizes delivery to Case Opener (B) where carton flaps are lifted out. Unopened flaps or inverted jars cause automatic case rejection. Normal cases proceed to Uncaser (C) where the case and divider panels are pushed down and away from the jars. Uncaser deposits jars on transverse-channeled conveyor platens. Blades slide jars from channeled platens into pocketed belts which hold jars inverted through Washer (D). Jars are plowed from washer belt pockets to transverse-channeled combining and accelerating belts—moving 350 to 400 jars per minute . . . are then "shuffled" into the "Single-Filer"—550 to 650 jars per minute on a channeled belt to Filler (E). Rubber starwheels minimize breakage in feeding the 25-pocket Girdler Filler (E), and 16 twin-head Anchor-Hocking rotary Capper (F) . . . both custom-built for Gerber with center-to-center jar spacing for positive, smooth glass transfer between units. Smooth synchronization, cushioned acceleration and deceleration provided by the Oilgear Drive and Control System, combined with no jar-to-jar contact make possible the almost noiseless higher speeds and virtual elimination of glass damage . . . for if even a single jar or bottle is broken in food or pharmaceutical operations, a complete and costly shutdown, cleanup and inspection of the packaging line by quality control personnel is required.

SOLUTION: An Oilgear "*Any-Speed*" Drive, consisting of a Type "DA-1211" variable displacement pump and three Type "H-811" constant displacement motors—powers all elements of "The Gerber Integrated Glass Lines" to *meet and exceed originally specified drive requirements.* For maximum work area around the "Glass Line," prevention of possible food contamination, and use of an economical electric motor, the Oilgear "*Power-Pak*" is located on a different floor of the building. A compact control panel located at the Filler enables the operator to start, stop, jog, and instantly vary speed of the entire machine through an infinite range while the machine is running—thereby obtaining maximum efficiency for the consistency of the food being filled. The drive system automatically synchronizes the speed of all seven machine units. Operating speed ranges from 550 to 650 jars per minute—depending entirely upon the products being filled . . . *an increase of up to 23% over former conventional glass packaging methods.*

GERBER REPORTS—"*The major advantages of this newly developed equipment are: less shock and scratching of jars, which reduces damage; substantially higher speeds: more thorough washing; lower maintenance cost and automatic control of all segments of the line.*"

Due to the smooth, cushioned application of power, even at higher speed, reduced glass damage and the resulting reduction in downtime, maintenance and labor costs with this Oilgear-powered, Gerber-designed machine, an expanded installation program of these "Integrated Glass Lines" is now under way at all Gerber plants.

Circle 655 on Page 19

"PLUS" features of this Oilgear Drive and Control System are: dual, automatic, built-in hydraulic and electric overload protection—stops the machine in event of jamming or malfunction . . . automatic hydro-dynamic braking . . . direct torque reading at the control panel . . . constant pressure and flood lubrication with continuous power fluid filtration . . . complete flexibility for location of drive and control components . . . fast, easy installation . . . standard drive and control components sealed against washdowns . . . lower power consumption—using only power in proportion to work performed. There are many more—but these alone should be sufficient proof why designers and builders of machinery are turning to Oilgear, and say . . . "*for the lowest cost per year—it's OILGEAR!*"

For similar practical solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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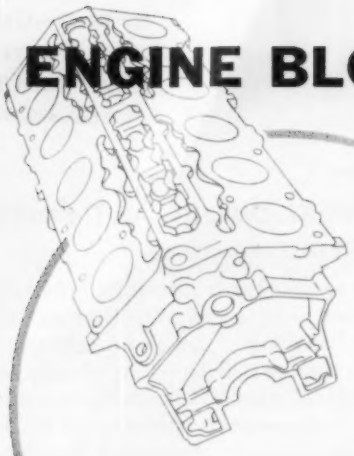
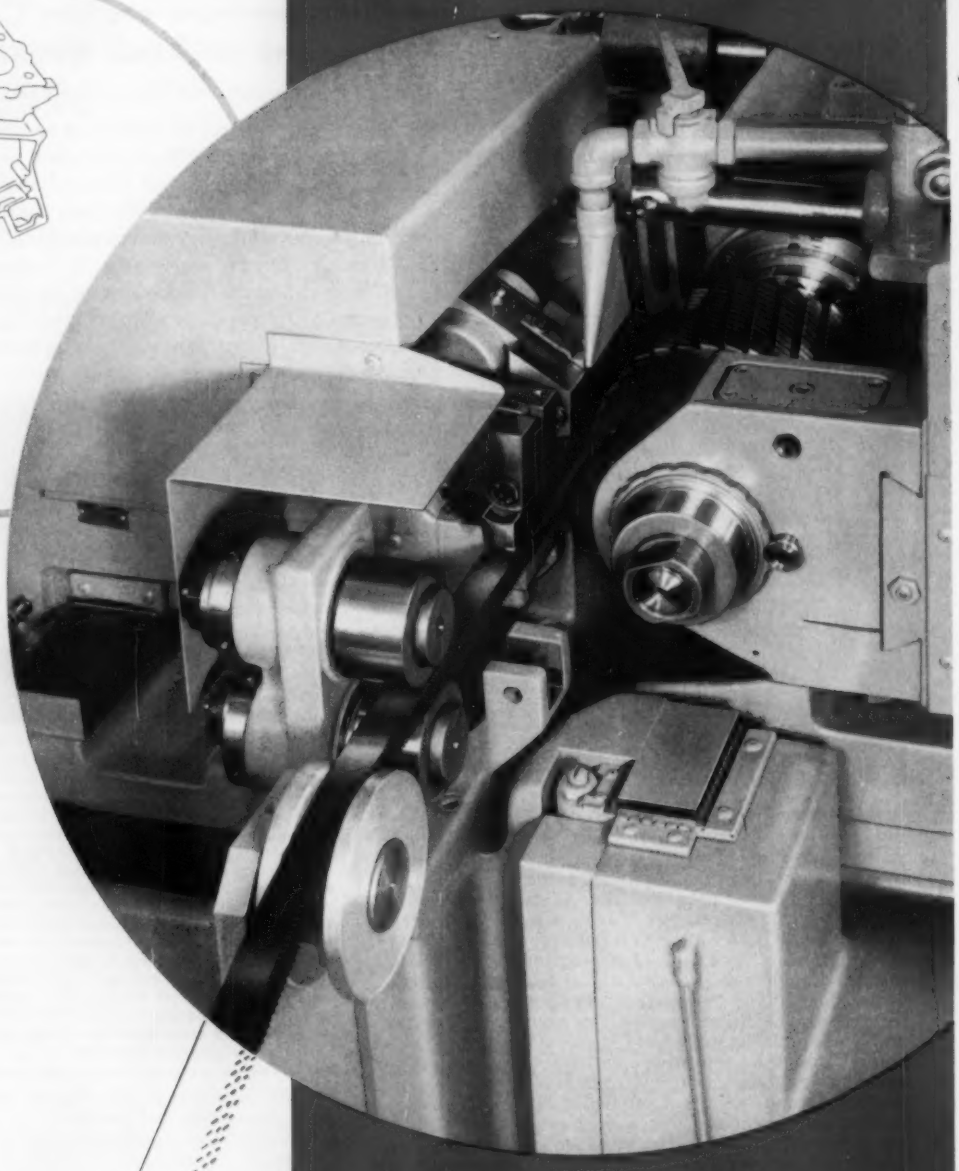
ENGINE BLOCKS *and* BAND SAW BLADES.





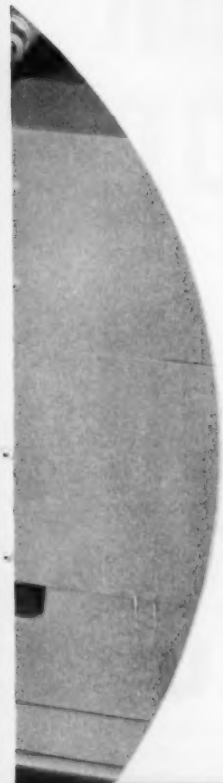
Center of action, CINCINNATI Automatic Band Saw Blade Milling Machine.
OPERATION.....mill saw teeth
MATERIAL.....high speed steel
STOCK REMOVAL.....from solid
Entire machine is shown at the right.

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • VERTICAL AND HORIZONTAL BROACHING

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

▪ ▪ ▪ *produced at lowest cost on machines built by*

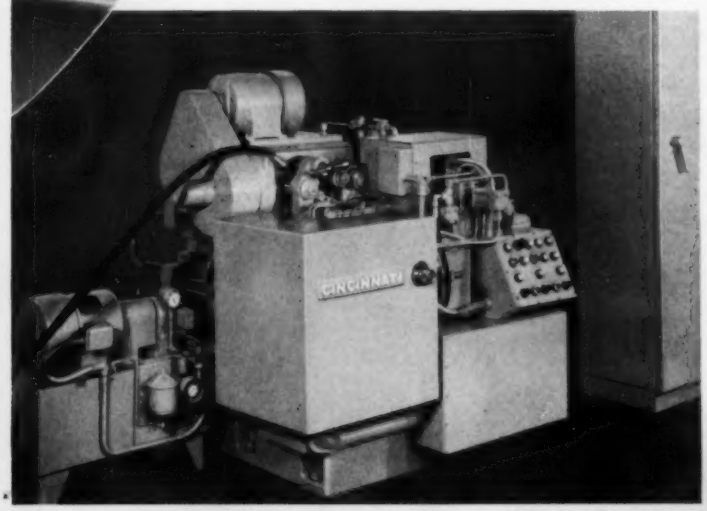
CINCINNATI | SPECIAL MACHINE DIVISION



Whatever the product, industry today shares a common problem . . . how to increase productivity and decrease costs. And the solution frequently is found in Cincinnati Milling's Special Machine Division, who design and build special machines and complete production lines for any industry.

Milling the teeth in band saw blades affords an interesting example of the Special Machine Division's dependable productivity. Their engineering specialists devised an automatic milling machine with a unique shuttling arrangement. In a completely automatic operation the stacked blades are advanced from reels by the shuttling action of the dual clamping fixture; saw teeth are milled with a 4″ wide cutter, and a box milling cycle permits continuous clamping of the blades. The work advances for the next phase as the milling cycle is completed. The driving gear on the full size 50 Series machine spindle is larger than the cutter itself, delivering the maximum capacity built into the machine.

What's *your* machining problem? Whether it's a simple twist drill, a band saw blade, or a complex engine block requiring a completely engineered production line, the Special Machine Division is ready to serve you.



CINCINNATI

MACHINES • COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI®

SPECIAL MACHINE DIVISION

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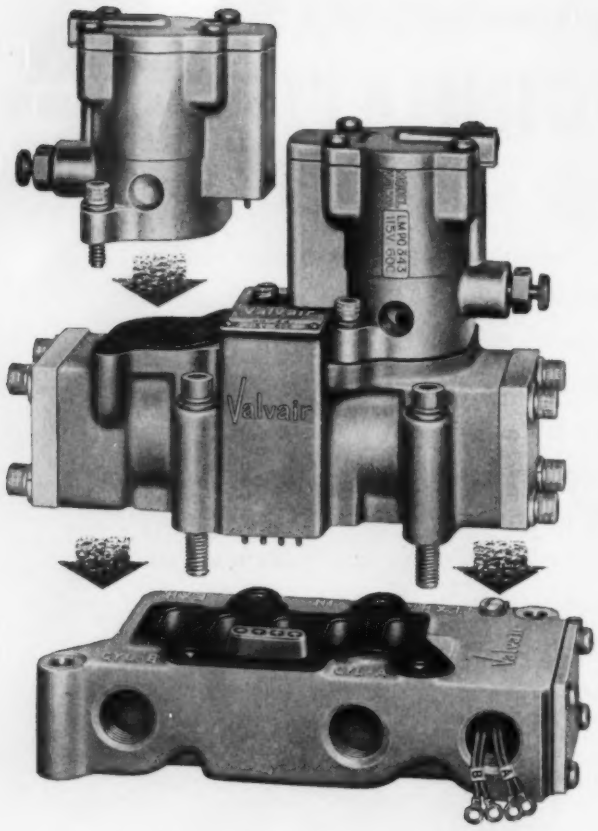

VALVAIR® ½" NPT PLUG-IN VALVES

MODEL PD-441 shown. 4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-million cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for ac or dc, any voltage . . . 35 — 200 psi range . . . integral junction box . . . optional manual over-ride, common or separate exhaust ports, sub-base connected external pilot supply . . . ¾ in. exhaust ports, ½ or ¾ in. inlet and cylinder ports . . . valve meets JIC standards.

Based on the service-proved design principle of the Speed King ¼ in. plug-in Valvair's ½ - ¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result — cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your near-by Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletin SPL. Address Dept. AU-960 Bellows-Valvair, Akron 9, Ohio

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The Bellows Co. • Valvair Corp. Akron 9, Ohio

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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AUTOMATION news

Today's events and developments in the field of automation

Computer Controls Batching In Ice Cream Production

ICE CREAM production is automatically programmed at the H. P. Hood & Sons Co. Inc. plant in Boston, with a system that includes a computer to calculate mix formulas. The computer, an analog-to-digital type, electronically computes the formula for any batch within an accuracy of 0.02 per cent of full scale. Formulas, translated by the computer into digital form, are recorded directly on punched cards used to program an automatic blending system. The over-all system was conceived by a team from the Hood Co. and developed in collaboration with Brown Instruments Div., Minneapolis - Honeywell Regulator Co.

Calculation of mix proportions of ingredients for ice cream is ordinarily a complex operation. For example, different basic mixes vary in butterfat and milk solids, while non-dairy ingredients vary in formula according to flavor and quantity. Also, the mix for a given formula must be recalculated daily due to fluctuations in the constituents of the dairy products.

CONTROL CENTER for automatic ice cream formulating and batching system includes analog-to-digital computer (rear), punched card programming control (left), and graphic control panel (right). With the system, ice cream formulas may be computed, punched on cards, and the cards used to control flow of liquid ingredients from storage tanks to batching tanks. Other functions that can be initiated from the control center include movement of completed batches through pasteurization, homogenization, and cooling units to mix storage tanks; and a clean-in-place cycle for pipe lines and tanks.

TO PREPARE a storage tank for cleaning, an operator disconnects the tank from a process pipe line and connects it to a cleaning solution line by means of an ell-connector. Cleaning cycle is initiated from control center.

The computer determines, by solving simultaneous linear equations, how much of each ingredient is required for a given formula and digitally converts this information into pounds on a coded punched card. In addition to its use for programming the automatic batching system, the card can be used for inventory and accounting purposes.

In batching, a punched card is placed in a card reader associated with a control console. This actuates a series of valves and pumps that control the simultaneous flow of all liquid ingredients from multiple storage tanks to one of two blending tanks. The control console, and remote turbine-type flowmeters that check the flow of liquids in the supply pipe lines, were obtained from Potter Aeronautical Corp.

From the blending tank, the completed mix is passed through pasteurization, homogenization, and cooling units. This operation may be initiated from a remote graphic control panel. When the mix in a balance tank is nearly depleted, a low-level probe is actuated and a *Select Tank* alarm and light are energized on the graphic panel. This informs the control operator that he should select an available mix storage tank for the batch. The mix is held in the storage tank to await further processing depending upon the type of product being produced.

Another function that can be programmed from the graphic control

panel is the in-place cleaning of lines and tanks after ice cream is made. Equipment that can be cleaned in this manner includes: raw product tanks and pipe lines; high-temperature, short-time (HTST) pasteurizer; pasteurizer pipe lines, and mix storage tanks. Both water and acid wash treatments may be programmed for tank cleaning. The only manual operation required in tank cleaning is the shifting of an ell-connection from a process to a cleaning solution pipe line.

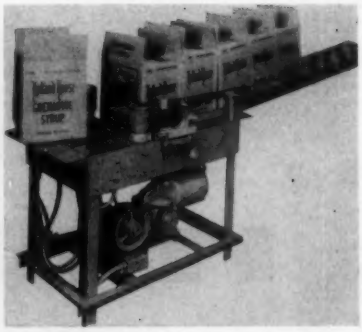
Coating Process Prolongs Feeder Bowl Life

DEVELOPMENT of a process for coating the bowls of vibratory feeders with any of several types of plastic materials promises to extend the applicability of these devices into areas where uncoated bowls are unsatisfactory. For example, many applications in the pharmaceutical and food processing fields require coated bowls for reasons of sanitation. In other instances, uncoated feeder bowls wear out too rapidly when handling corrosive, abrasive, or chemically active materials.

The coating process, developed by Polymer Corp., utilizes dry, specially prepared powders requiring no solvents or solutions. A coating is applied by preheating the feeder bowl above the melting point of the plastic, and immersing the bowl in a fluidized bed of finely divided powder. The powder is kept in motion by a controlled current of air or other gas within a tank.

Movement of the bowl in the fluidized bed ensures thorough contact between the heated surface and the powder particles so that even bowls having relatively complex shapes may be coated uniformly. Post-heating of the bowl then thoroughly fuses all the particles adhering to the surface.

Typical coatings that can be applied by the process include vinyl, epoxy thermosetting resin, nylon, and chlorinated polyethers. Selection is made on the basis of the properties required in the finished coating.



COCKTAIL MIX producer has doubled his carton marking rate with the addition of an in-line case printer. The marker, designed and manufactured by Industrial Marking Equipment Co. Inc., simultaneously marks the contents of cartons on two sides by means of dual, friction-operated inking drums. Production rate is 45 cartons per minute, and bottlenecks due to delays formerly experienced with hand stencilling have been eliminated.

Continuous Blending System Handles Sixty Ingredients

DIGITAL blending system for the petroleum industry permits as many as sixty different gasoline and middle-distillate stocks and additives to be blended rapidly and accurately. The system, developed by Information Systems Inc., consists of four basic functional building blocks, each independent and allowing ready expansion of the system.

The four building blocks include a flowmeter assembly and control unit, an incremental-digital console, a central control panel with displays, and a localized remote control panel. The system is said to be capable of meeting a volumetric accuracy of ±0.5 per cent.

In operation, the flowmeters supply flow rate data to the digital

Chicago Host To Three Industrial Events

NUMERICAL CONTROL will be a prominent feature of the 1960 Machine Tool Exposition to be held Sept. 6-16 at the International Amphitheatre in Chicago. Sponsored by the National Machine Tool Builders' Association, the event will provide an opportunity for top industry executives, plant managers, engineers, and others concerned with production to view the latest in U. S. machine tool technology.

Of the more than 1000 major machines that will be shown, a large number will be equipped with combinations of memory units and tape controls, designed not only to expedite the setup of a wide variety of machining jobs, but to facilitate the rapid and accurate production of any desired number of identical parts.

Theme of the Production Engineering Show, being held concurrently at Chicago's Navy Pier, will be automation of manufacturing operations. Equipment and products displayed at this show keep machine tools running and contribute to more automatic production and processing operations. Products displayed will include control equipment of various types, machine components, auxiliary equipment and supplies, materials handling equipment, inspection and gaging equipment, and testing equipment.

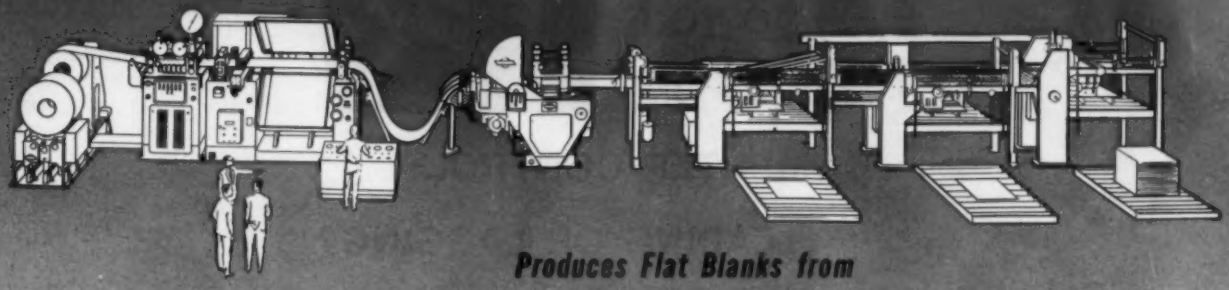
The third attraction to bring production-minded visitors to Chicago this month will be the 2nd International Coliseum Machinery Show. This exhibit will be held Sept. 7-15, and will be headquartered in Chicago's Coliseum. Featured will be machines and auxiliary equipment from foreign countries including Belgium, Canada, England, France, Italy, Japan, and West Germany. Some U. S. equipment builders will also be represented. Theme of the Coliseum Machinery Show will emphasize profits through machine application.

Exposition hours from 10 a.m. to 5:30 p.m., and Show times between 1 p.m. and 10 p.m., will provide an opportunity for visitors to attend all three events in a single day.

ONE SOURCE... LITTELL

engineers, integrates and guarantees this

HIGH SPEED SHEETING LINE



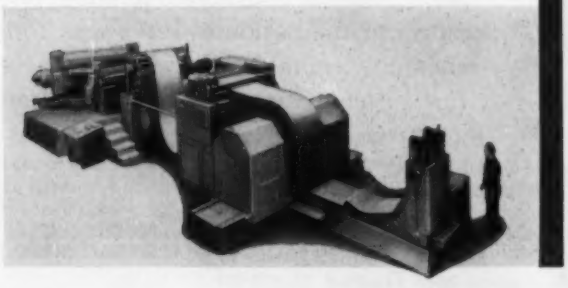
Produces Flat Blanks from Coil Stock .0055" to .020" ACCURATELY—within .007" in Length and Squareness FAST—75 three-foot blanks per minute!

TYPICAL LITTELL TINPLATE SHEETING LINES

At Crown Cork & Seal Company, these lines convert coil stock into flat sheeted tinplate, cut square, and to accurate lengths, in one continuous, automatic operation.

TYPICAL LITTELL TRAPEZOID SHEETING LINE

For The Budd Company, this Littell Trapezoid Sheeting Line converts heavier coil stock into custom cut rectangular, parallelogram and trapezoidal flat blanks for subsequent stamping and drawing operations.



The accuracy, the speed, and the low cost production record of this Littell line has made it standard equipment with the most exacting metalworking manufacturers. One company alone has 24 of these lines producing flat blanks. In every instance where the line has gone into service, the user has ordered more!

Littell engineers *and guarantees* the five complex individual units in the line to operate as one. Each unit is integrated and synchronized, one with the other, to produce flat blanks from mill coils faster, more accurately and at lower cost than has been possible before. Littell *guarantees* a tolerance of ±.007" in length and squareness in producing blanks up to 36" long at the rate of 75 blanks per minute. You get this accuracy on paper-thin .0055" tinplate or steel stock .020" thick. Operation is automatic, controlled by one man. Imperfect blanks are automatically rejected by electronic controls. Can manufacturers report the Littell line's scroll cutting efficiency saves six percent in material.

Whether you work thick or thin stock, a Littell Sheeting Line can work to your advantage and quickly pay for itself. Let's talk it over. 'Phone or write.

COILY SAYS:
"When you call or write, be sure you ask for Bulletin G-10."

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Circle 658 on Page 19

WHERE DO YOU STAND ON COMPUTER CONTROL— LEADING OR LAGGING?

Far-sighted leaders in industry are realizing the benefits made possible by applying computer control systems to their processes.

Working with these leaders, General Electric has already pioneered the application of twenty on-line GE-312 computer systems now being implemented in these basic areas —STEEL, ELECTRIC UTILITIES, CHEMICAL, CEMENT, and PRODUCTION CONTROL for various manufacturing applications.

The GE-312 Computer Control System embodies adaptability and flexibility to meet many types of applications in varying size plants. For example, compare its expansible memory—capacity up to 52,000 words. Compare its flexible input/output—capable of scanning up to 1500 instrument inputs. These are maximum capabilities, expansible from a minimum system. You buy a system tailored to your exact requirements.

Add to this versatile equipment the computer systems engineering ability demonstrated by General Electric in implementing these twenty GE-312 system applications.

Add also the long history of General Electric overall systems know-how—its broad background in the equipment, processes and materials to which you apply computer control.

Tomorrow's profits will come from today's combination of vision, equipment, and know-how. *Where do you stand?*

There are General Electric Sales and Application engineers in over one hundred offices throughout the nation to serve you. *Phone* the nearest General Electric Apparatus Sales Office, or *wire* General Electric Computer Department, 13441 North Black Canyon Highway, Phoenix, Arizona.

PROCESS CONTROL
AUTOMATED BY GENERAL ELECTRIC

Progress Is Our Most Important Product

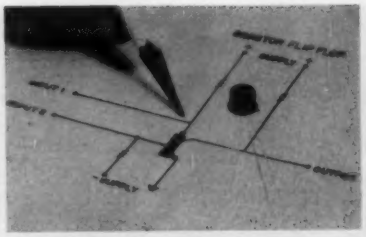
GENERAL ELECTRIC

CPA-50 (9-60)

General Electric—a pioneer in computer systems for all phases of business, industrial, scientific, engineering, and financial endeavor.

console. There, actual and integrated flows are compared with command flows. If an actual flow condition does not agree with a commanded flow, digital correction signals will be generated to execute an adjustment to the flow rate. Outputs from the digital console are dc voltages. These control voltages are fed through transducers to diaphragm motor valves on the individual stock and additive streams.

Although the system is based on predetermination of the desired composition of blends, it is also possible to expand the digital controller capacity to permit it to determine the optimum composition of each blend, taking into account variations in octane numbers, vapor pressures, and other base stock properties, as well as relative refinery costs of the various base stocks and additives.



SILICON semiconductor device designated binistor, has been developed by Transitron Electronic Corp. Designed for use in switching and storage circuits, the bistable device retains its properties over a wide range of ambient and bias conditions. Illustration shows an application in which one binistor and three resistors comprise a flip flop circuit.

POST OFFICE contract awarded to Friden Inc. has been announced by company president Walter S. Johnson. The contract specifies that Friden's International Postal Supply Div. will manufacture 59,000 money order issuing machines for approximately $3 million. All U. S. post offices will use the machines for issuance of money orders. Delivery and installation of the units will begin next December.

ISA Conference To Feature Industrial Instrumentation

PROGRESS THROUGH INSTRUMENTATION is the theme of the forthcoming 15th Annual Instrument - Automation Conference and Exhibit, sponsored by the Instrument Society of America. The event will be held at the Coliseum in New York from Sept. 26-30. Approximately 400 exhibitors will dis-

Processing Line Operates In Inert Atmosphere

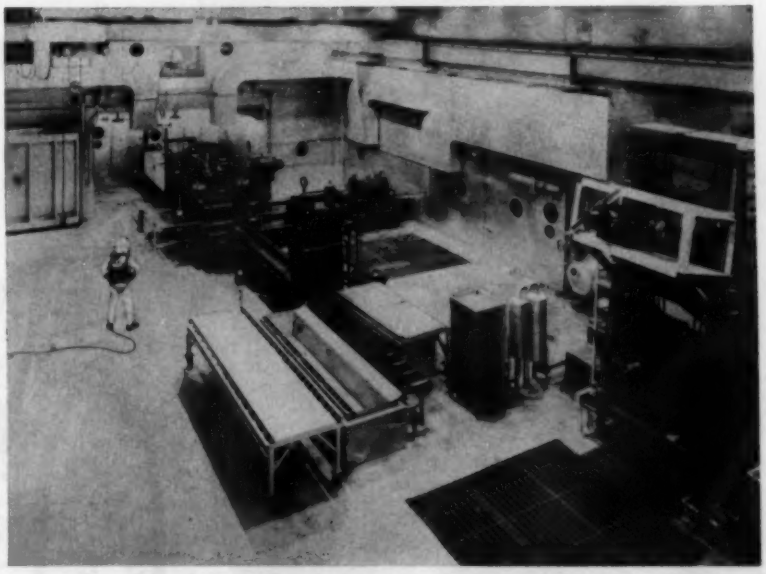
PRODUCTION of high-integrity mill products from refractory metals such as molybdenum, tantalum, tungsten, and their alloys ideally should be carried out at high temperatures in an inert atmosphere. But the sealing of individual processing machines to maintain inert atmospheres in their working areas is difficult.

Solution adopted by Refractomet Div., Universal-Cyclops Steel Corp. has been to house the equipment in a welded steel enclosure in which air can be replaced by high-purity argon. Inside the enclosure are an impactor, a rolling mill, furnaces, and a 10-ton crane. Space is available in the 42-foot wide, 97-foot long, and 23-foot high enclosure for additional equipment.

The impactor, rolling mills, and furnaces were designed for automatic operation and are controlled from consoles outside the facility. An operator at each console has a full view of the equipment through a special glass window which filters out ultraviolet rays emitted by the white hot metal.

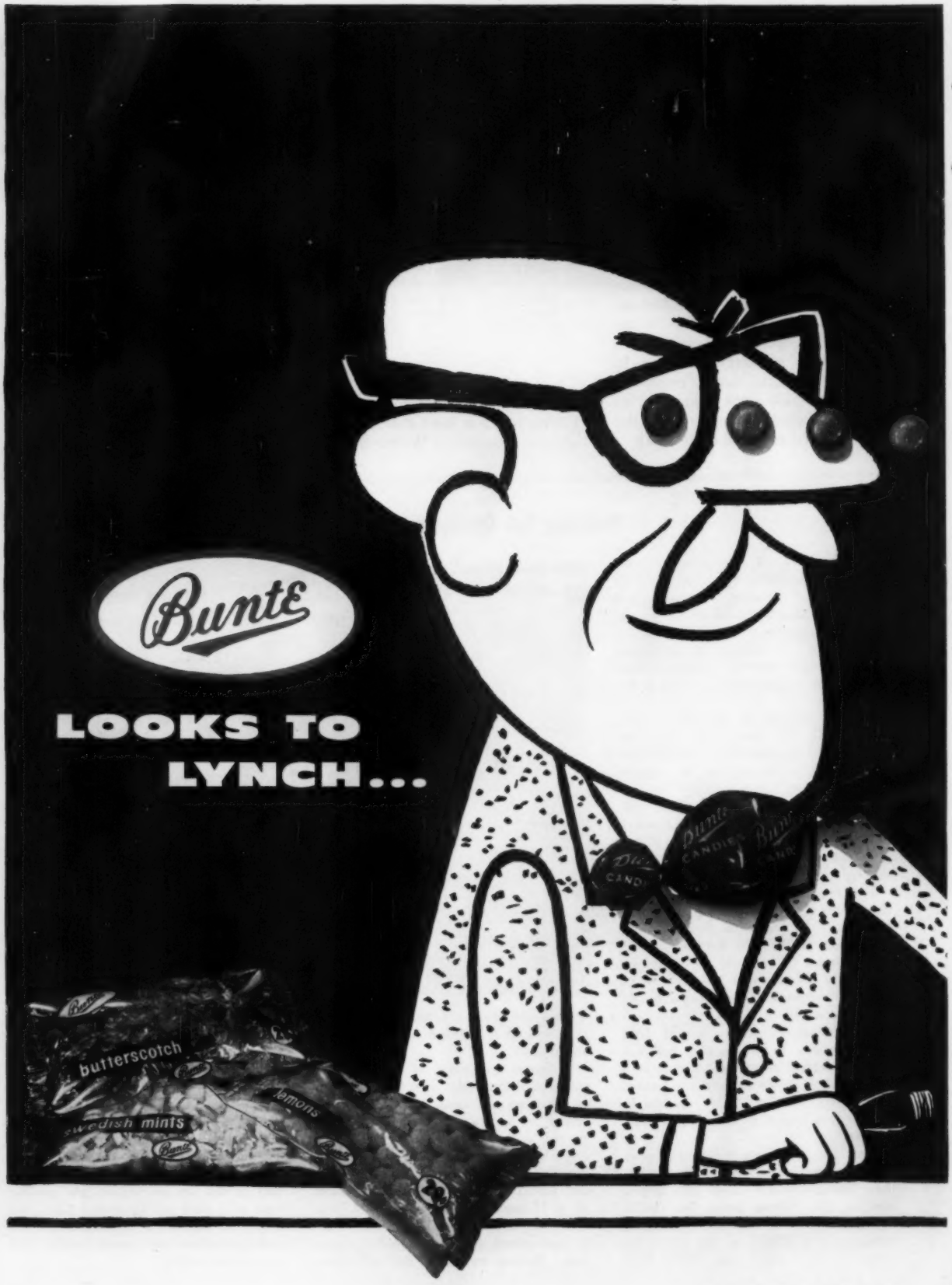
The refractory metals, formed from metal powders by compaction and sintering, are first melted into ingots in a consumable-electrode vacuum arc furnace. The furnace produces 12-inch diameter by 70-inch long ingots weighing up to 3000 pounds.

Next, the ingots are heated in induction furnaces located beneath the impactor. Then, they are raised into forging position and broken down into billets or sheet bar in the impactor. Processing temperature is 4500 F as the ingots are struck on two sides with 15,000 foot-pounds of energy. Operating force for the impactor is obtained from compressed argon gas.



If further processing is required, the billets and sheet bars may be transferred to a rolling mill area. There, they are heated in an indirect induction furnace at the end of the rolling mill table. From the furnace, the materials go to a two-high, 16 by 36-inch rolling mill that can produce either round bars or sheets up to 15-inches wide and 96-inches long. Processing temperatures up to 4000 F may be maintained during the rolling operation. Remote control of the roll tables, bar turner, pinch rolls, and an alligator shear permits automatic operation from outside the room.

Some manual handling is required in taking materials into and out of the facility and transferring them between machines. This is accomplished with the aid of the crane by technicians who enter the enclosure through a lock. Each technician wears special protective clothing and carries an air supply and cooling unit in a pack on his back. Upon entering the room, the technician connects communications and power supply lines to a service outlet.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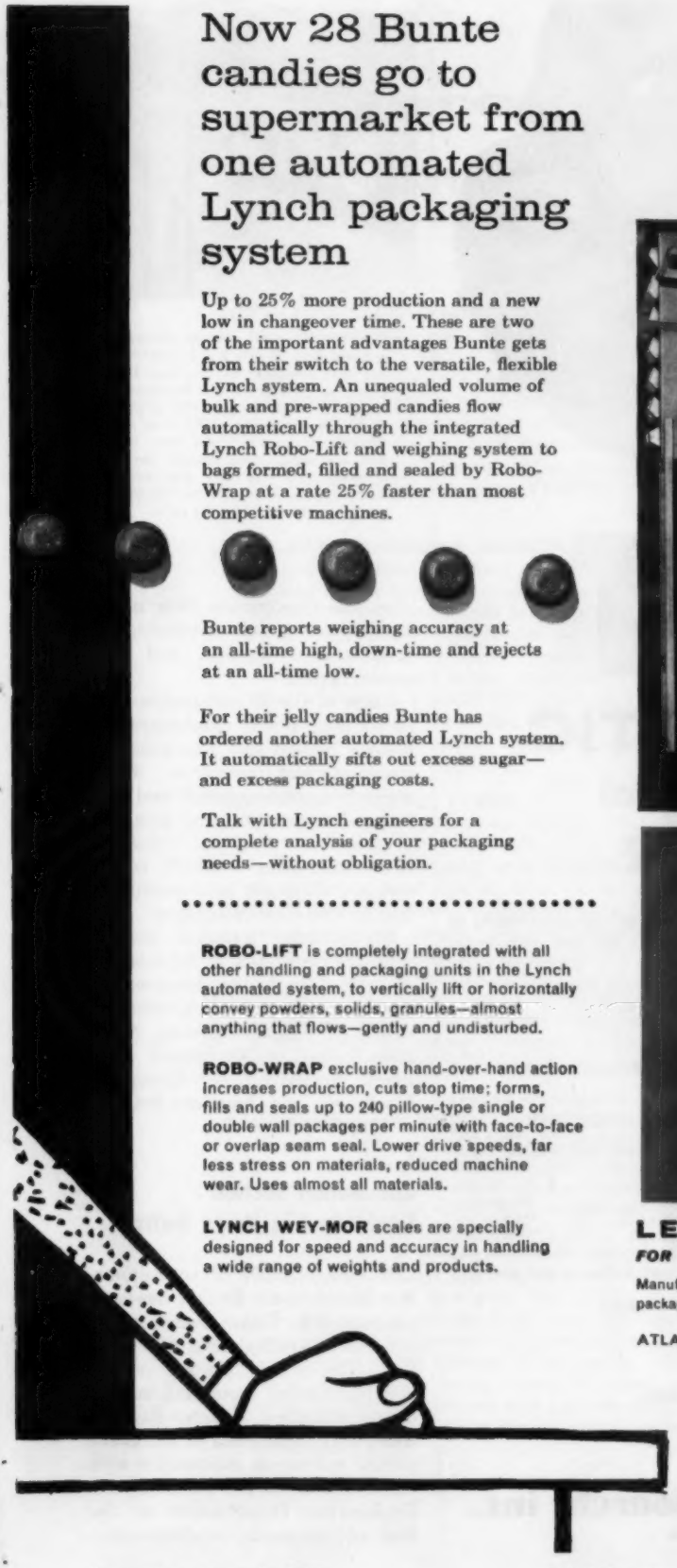
LOOKS TO
LYNCH...
butterscotch
lemons
swedish mints

Now 28 Bunte candies go to supermarket from one automated Lynch packaging system

Up to 25% more production and a new low in changeover time. These are two of the important advantages Bunte gets from their switch to the versatile, flexible Lynch system. An unequaled volume of bulk and pre-wrapped candies flow automatically through the integrated Lynch Robo-Lift and weighing system to bags formed, filled and sealed by Robo-Wrap at a rate 25% faster than most competitive machines.



Bunte reports weighing accuracy at an all-time high, down-time and rejects at an all-time low.

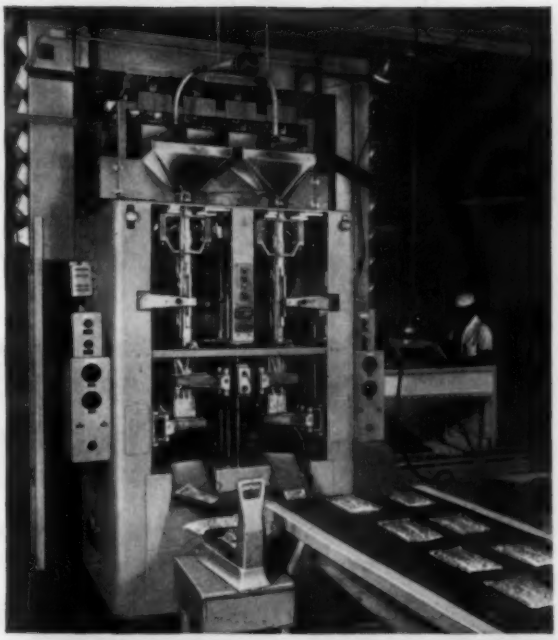
For their jelly candies Bunte has ordered another automated Lynch system. It automatically sifts out excess sugar—and excess packaging costs.

Talk with Lynch engineers for a complete analysis of your packaging needs—without obligation.

ROBO-LIFT is completely integrated with all other handling and packaging units in the Lynch automated system, to vertically lift or horizontally convey powders, solids, granules—almost anything that flows—gently and undisturbed.

ROBO-WRAP exclusive hand-over-hand action increases production, cuts stop time; forms, fills and seals up to 240 pillow-type single or double wall packages per minute with face-to-face or overlap seam seal. Lower drive speeds, far less stress on materials, reduced machine wear. Uses almost all materials.

LYNCH WEY-MOR scales are specially designed for speed and accuracy in handling a wide range of weights and products.



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Circle 660 on Page 19

e·m·r

13 BIT ALL-MAGNETIC Shaft-Position Digital ENCODER

In any environment, in all applications, ASCOP magnetic encoders have proved to be rugged and tough. Our customers say that nothing compares to them for endurance and perfect performance under the worst conditions.

Now ASCOP has taken the same unique magnetic readout principle and incorporated it into a neatly miniature, ruggedly simple design to read out shaft positions to one part in 2^{13}. Parallel output is in binary code and total count is reached after 64 turns of the precision shaft and gearing. Lead-lag head arrangements assure that external decision making circuitry is minimized. The new ASCOP encoder operates in either direction and can be read out at rest or on-the-fly at speeds up to 10,000 rpm with equal facility. Since the only contacting parts are shaft and gearing, these are the only factors affecting life.

Condensed Specifications

Total Count: ..... 2^{13} achieved in 64 turns of input shaft
Size: ..... 2¼" dia. x 3⅛"
Code: ..... Binary with lead-lag heads
Output: ..... Parallel
Weight: ..... 16 ozs.
Inertia: ..... 70 gm-cm²
Breakaway Torque: ..... 0.05 in. oz.
Max. RPM: ..... 10,000 rpm
Expected Life: 20,000 hrs. at 4000 rpm (expected bearing and gear life)

Brochure, price and applications notes on request

emr ASCOP

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P.O. Box 3041, Sarasota, Florida

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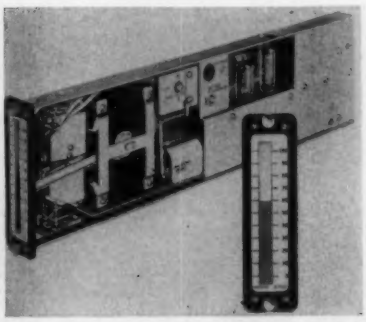

ELECTRONIC ribbon indicator occupying a panel area of only 2 x 5 3/16-inches has been developed by Swartwout Div., Crane Co. Instrument is a high-amplification, null-balance device that operates on a maximum signal of 0.5 v ac with full-scale accuracy of 1 per cent. High and low signal alarm contacts can be provided, and zero and span adjustments can be made with the instrument partially withdrawn from the panel.

play and demonstrate their newest equipment for data processing, instrumentation systems, and automatic control.

Some of the 50 technical sessions to be held at the Conference will feature papers and discussions on chemical and petroleum instrumentation, measurement and control instrumentation, and data handling and computation. Other sessions will cover feedback control systems, electronic instrumentation, and process chromatography.

Co-operating technical societies that will participate in the extensive program include the American Institute of Chemical Engineers, Institute of Radio Engineers, American Society of Mechanical Engineers, Association for Computing Machinery, and American Institute of Electrical Engineers.

Automation Section Established at Union Switch

ORGANIZATION of an Automation and Systems Section has been announced by Union Switch & Signal Div., Westinghouse Air Brake Co. The prime function of this new engineering group will be that of co-ordinating design, development, and application of automatic control systems in coniunction with other sections of the Research and Engineering Departments in the field of automatic, semiautomatic,

around the triangle

SYSTEM FINDS AND RECORDS FILE DATA

Magnetic tape searchwriter developed by Remington Rand Div., Sperry Rand Corp., automatically searches a magnetic tape file for a desired item and either types the information or punches it on paper tape, or does both. Requests for file information retrieval are originated from a typewriter keyboard or from prepared paper tape. Designed to be used with the Uniservo II, the equipment permits finding and recording taped information without consuming computer or programmer time. It can also be used as an error-checking interrogator. An eight-page booklet describing the system is available from the manufacturer.

NOW—A PROBLEM-MAKING COMPUTER

In an effort to better understand the effects of automation on men who supply the necessary human element in complex man-machine systems, a problem-making analog computer and control panel have been designed by Battelle Memorial Institute. For instance, the system can simulate the conditions facing an operator of the complex controls used in a chemical processing plant. The control panel, in effect, demands that the operator remain constantly alert to answer three questions: 1. Is the system operating as it should? 2. If it isn't, what correction should be made? 3. Was action taken effective in correcting the system? Ultimate goal of Battelle scientists is to determine optimum balance between the workloads of men and machines.

TELLS IF IGNITRONS FAIL TO FIRE

A misfire detector for resistance welding control equipment has been developed by General Electric Co. With the device, any misfire of the control's ignitron contactors trips a relay and gives an indication to the welder operator. In addition to operating a signal light or horn, the device can actuate a counter, marking device, reject mechanism, or shutdown circuit. In welding control, ignitron contactors operate on alternate half-cycles to switch current into a welding transformer primary. If one tube fails to fire, the welder skips, and the second tube fires twice in succession. This may saturate the transformer and raise exciting current to a high value that could damage a tube. Use of the detector helps prevent overloading of the ignitrons and indicates when tubes need replacement. It also notifies the operator of improper welds. This feature is particularly useful in automatic seam welding of materials that have narrow plastic temperature ranges.

GAGES COATING THICKNESSES IN SMALL-BORE TUBES

Accurate measurement of coating thicknesses inside small-diameter, chromium plated tubes is possible with miniaturized gages developed by the National Bureau of Standards. In operation, a 100 kcps oscillator supplies ac power to a bridge circuit. A probe coil, connected in parallel with a tuning capacitance, forms one arm of the bridge. The alternating current in the probe coil, which is placed in contact with the coating, induces an eddy current in the coating. This induced current, which depends upon the thickness of the coating, is measured indirectly through the effect of its magnetic field, which opposes that of the inducing current. The opposition of the two fields lowers the impedance of the probe coil, thus unbalancing the bridge circuit. Degree of unbalance, measured with a microammeter, is a function of the thickness of the coating. Calibration of the instrument is made with specimens having coatings of known thicknesses. An assembly, consisting of a stainless steel tube with the probe on one end and a pistol-grip handle on the other end, facilitates insertion of the probe to depths of several feet in coated tubes.

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AUTOMATION

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AUTOMATION **September, 1960**

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410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
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420	460	500	540	580	620	660	700	740	780	820
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423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
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430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	769	799	839
440	480	520	560	600	640	680	720	760	800	840

AUTOMATION **September, 1960**

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406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
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438	478	518	558	598	638	678	718	758	798	838
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Iron & Steel Convention & Exposition

HIGHLIGHT of the upcoming 1960 Iron & Steel Convention and Exposition in Cleveland will be the trend toward increased use of automatic control in steel production. The Convention, sponsored by the Association of Iron & Steel Engineers, will be held at the Cleveland Auditorium, Sept. 27-30.

Featured will be 42 technical papers, and exhibits of advanced and standard production equipment by nearly 200 steel industry suppliers. Some of the developments to be reviewed at the technical sessions include: Advanced practices in automated steelmaking, new techniques for increasing blast furnace output, an automated rolling mill, and a new British oxygen steelmaking process. Reports on Soviet ferrous metallurgy, and steelmaking practices in Japan and India, will also be given.

or remote control for railroad operation.

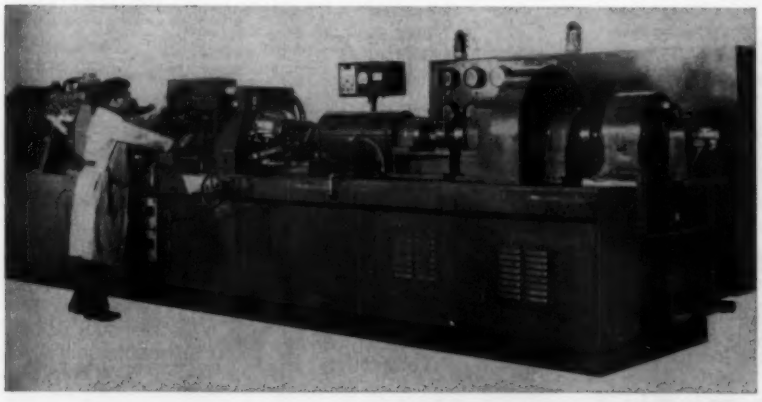
Need for such a section was recognized due to steadily increasing requests for information concerning possible applications of automatic equipment and also due to the receipt of orders for pieces of automatic equipment for application to full-scale train operations.

Supervisor of the new group is **Frank T. Pascoe** who, in 35 years of signaling experience, has worked in all phases of signaling. Most of this time was spent in the development of control circuits for centralized traffic control and numerous interlocking installations on many railroads.

Begins Study of Microcircuit Reliability

LARGE-SCALE study of the reliability of microcircuits has been initiated by International Resistance Co., according to **Dr. John J. Bohrer**, director of research. The project will emphasize performance characteristics of the circuits studied and will evaluate the ability of each unit to withstand environmental conditions involving temperature, moisture, shock, acceleration, and vibration.

Bohrer noted that the military services are becoming increasingly reliability-conscious with regard to new module, microcircuit, or mo-



AUTOMOTIVE transmissions are tested for reliability in this automatic machine developed by Control Engineering Co., a subsidiary of Jervis B. Webb Co. Primary functions of the unit are to simulate the weight of an automobile and the forces which act on a transmission, and to provide predetermined speed ranges and gear changes automatically or manually. An automobile engine, directly coupled to the input shaft of the transmission, provides driving power. The transmission, in turn, drives a 1000-pound flywheel that compensates for the automobile weight and forces. The unit is stopped automatically if performance of the engine or transmission varies from control settings. Friction and eddy current brakes may be applied singly or together.

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BEARINGS

If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.

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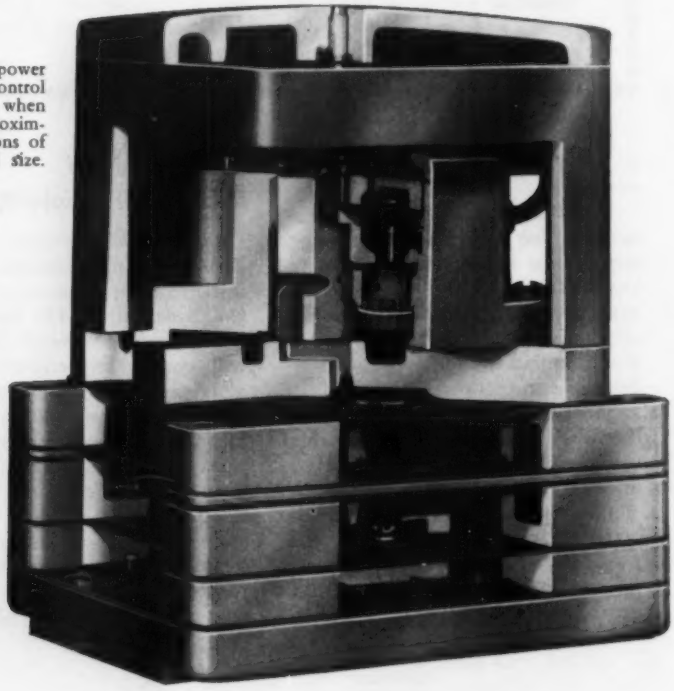
Circle 662 on Page 19

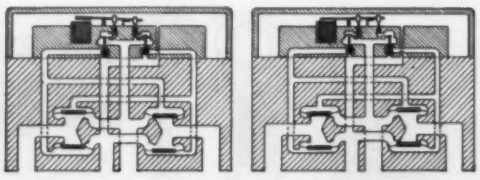
IT CUTS COSTS! RESPONDS FASTER!

Honeywell announces trouble-free pneumatic

An entirely new concept in pneumatic power amplification. Provides accurate, instant control of pneumatically operated power cylinders when coupled with manual, cam-operated, or proximity switches. Available in 48 combinations of action, coil voltage, port location and size.



One power head is adaptable to all types and many sizes of valves. Shown here is the ½" model; above is the ¼", illustrating how a change of manifolds permits various valve sizes.



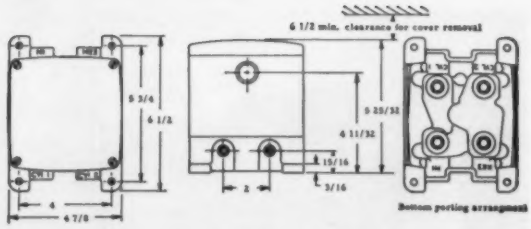


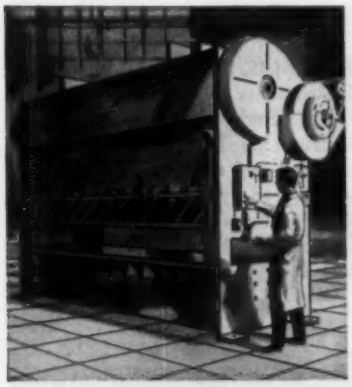
Fig. 1 - 1/4 in. model dimensions

Only Honeywell offers these time and money-saving features!

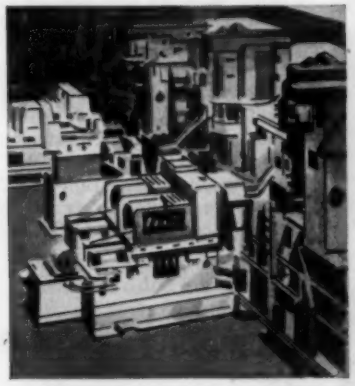
- **Completely flexible design**—the same power head is used for all valve sizes. Choice of many porting arrangements. Reversible power head.
- **Long life**—⅜" and ½" models built to operate in excess of 20 million cycles—¼" size in excess of 40 million cycles!
- **Maintenance-free.** No preventive maintenance required up to 20 million cycles. No lubricator, no filter needed.
- **Fast response—high capacity**—can be cycled up to 1000 CPM on and off cycles with 80% dumping into 12 cu. inches. One cycle takes only .00005 cfm. Fast sequencing—immediate response.
- **JIC** Built to JIC standards, captive screws, chained cover, and fail-safe. Inoperative with cover removed. Manual operator.
- **Lowest power consumption** of any valve available. Recognizes minimum electrical signal. One va.

the most flexible valve of its kind!

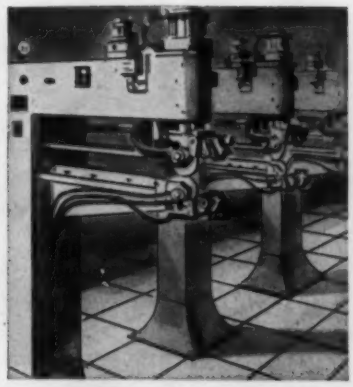
One power head adapts to all types and many sizes of machine tool valves . . . operates over 40 million cycles without preventive maintenance



Fast response and long life of more than 40 million cycles solve two of the biggest problems in press operations.



Little or no maintenance or lubrication required makes this new valve ideal on transfer machines where dependability is important.



Chamber coil is guaranteed not to burn out, even when subjected to prolonged stalled positions as in welding operations.

Compare, and you'll find that here at last is a valve built to give service, rather than to be serviced. Compare, and you'll find this the most *adaptable* pneumatic valve ever designed for transfer line, punch press and welding machine operations.

Never again will you have to disassemble pipes and fittings to change a valve. A change of manifolds permits either ¼", ⅜" or ½" valve sizes—makes it a 3-way or 4-way valve. Reverse the power head and you change it from a reverse to a direct-acting valve. Even the porting arrangements can be changed—bottom-side, side-bottom, and similar positions. And because one power head is adaptable to all types and many sizes of valves, you can hold your stock of repair valves to a minimum. Coils are available to work directly from static switching circuits.

And consider these added advantages. You get fast response, high capacity, lowest power consumption—all at lowest cost, with little or no maintenance required. Extremely rugged shockproof construction, oil- and moisture-proof seals, lightweight and compact size make this valve adaptable to almost any mounting location. All this, plus a durable oxidized finish which can be painted any color if a change is necessary.

For long, trouble-free service and money-saving features, you'll find that no other valve compares with Honeywell's new V4032A, B & V4033A. For more details, call your local Honeywell office; or write: Minneapolis-Honeywell, Minneapolis 8, Minnesota, and ask for Form No. 95-2597.

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Honeywell

First in Control

SINCE 1885

See us in Booth 269 Production Engineers Show, Sept. 6-16

Circle 663 on Page 19

Heat liquids .....at the turn of a dial

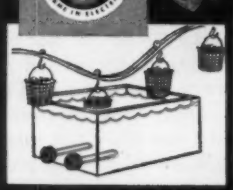
CHROMALOX ELECTRIC HEAT

Fast, uniform, economical, safe

Just drill and install threaded pipe coupling in tank, then screw in the Chromalox Immersion Heater. Built-in thermostat automatically maintains uniform temperature of water, oils, paraffin, wax, various solutions. Several styles available, for different applications. Elements sheathed in copper or steel. Standard ratings from 50° to 550°F., ¾ to 10KW, 120 or 240 volts. Inside-tank extensions from 6¼" to 48". Available with explosion-resistant and moisture-resistant terminal box. Prices start under $20.

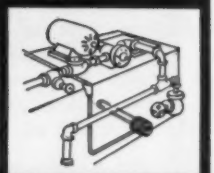
For more details, call your Chromalox Sales-Engineering Representative, or write us for Bulletin PD105, which contains specifications and prices.

01001



Cleaning and degreasing solutions.

Quenching oil.



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lecular electronic products. "It is up to both the makers and users of these components to provide the necessary proof," he added.

SIX-STAND, 52-inch cold reduction mill that will operate at speeds up to 6600 fpm has been ordered from Blaw-Knox Co. by U. S. Steel Corp. for use in a tin mill operated by its Tennessee Coal & Iron Div. in Fairfield, Ala. The installation will comprise U. S. Steel's first six-stand cold reduction mill for use in tin plate manufacture. According to a company announcement, the order specifies a mill that will incorporate automatic features beyond any that have been used before.

New Division For Scientific Instruments

ESTABLISHMENT of a Scientific Instruments Division for the manufacture and marketing of scientific instruments for the chemical, biological, and medical fields has been announced by **Dr. D. L. Jaffe**, president, Polarad Electronics Corp. **Charles French** has been appointed manager of the new division. He

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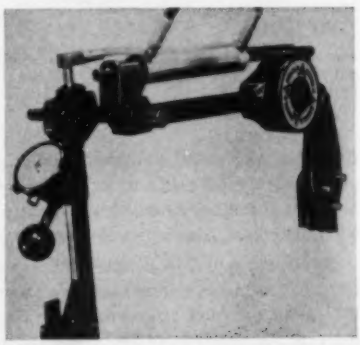
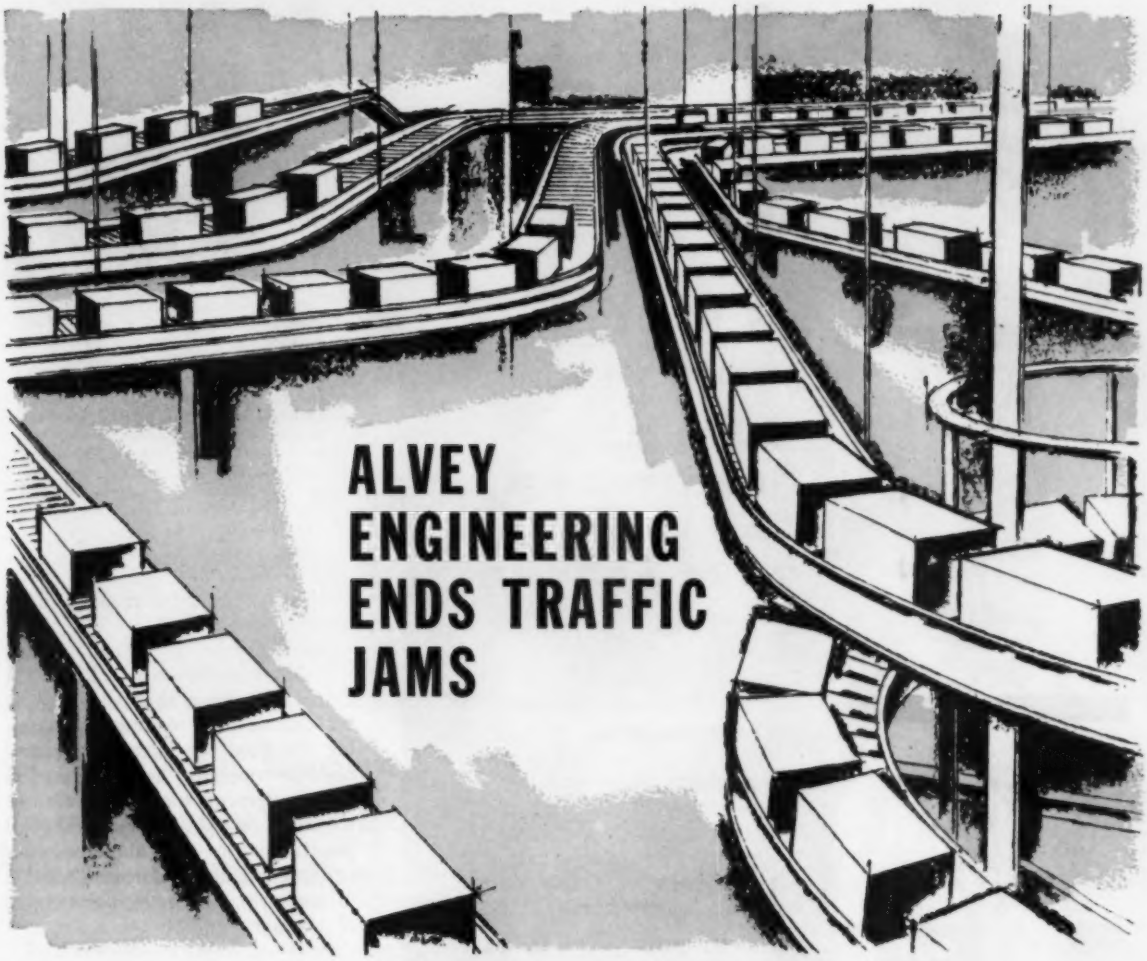


HYDRAULICALLY operated actuator automatically positions and retracts a continuous grinding gage in plunge-grinding operations. The actuator, announced by Federal Products Corp., consists of a ball bearing mount and a support arm working in conjunction with a single hydraulic cylinder and a cam-actuated rod. Unit carries the caliper to a position in front of the workpiece where, through cam action, the caliper is brought into gaging position. At the end of a measuring cycle, the action is reversed and the gage is returned to its rest position. The actuator can be operated by the grinder hydraulic system or it can be controlled by external means.



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- **Back-up on your production line**
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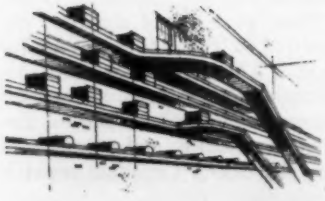
- **Merchandise damaged needlessly**
- **Pile-ups at your loading docks**
- **Excessive personnel "stand-around" time**



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Alvey will revise your present layout or start from scratch with you, on any size job. Call or write for free consultation.

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ALVEY CONVEYOR MANUFACTURING CO.

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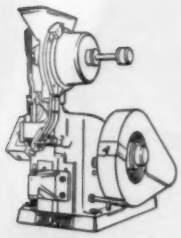
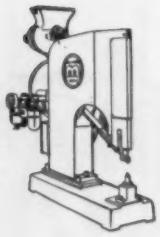


Model 52-S-55



Model 56

Model 250

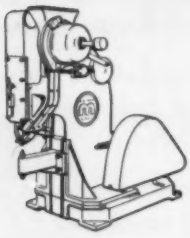
MILFORD'S FLEXIBLE RIVETER LINE CAN HELP CUT YOUR ASSEMBLY COSTS

Bench or Pedestal Models
Mechanical or Pneumatic Operation
Single or Multiple Spindle

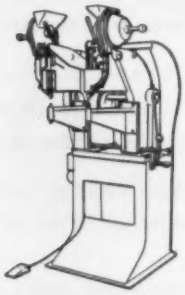
Milford adapts to your production line with a wide range of automatic riveters designed to cut assembly costs. Count on Milford's versatility to come up with the answers you need at substantial cost savings over other fastening methods.

Milford's MANUAL OF RIVETING PRACTICE may have the answers to your riveting and assembly problems. Ask your Milford Representative to show you how to use the ideas in this manual to cut production costs.

Model 423



Model 53



Model 72

THE MILFORD RIVET

MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • NORWALK, CALIFORNIA
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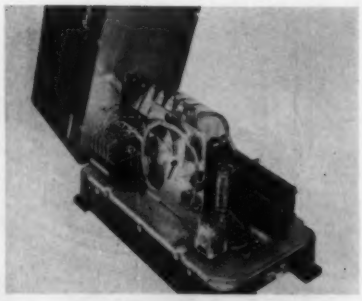


PRE-RECORDED tapes give spoken flow meter reports when this unit, developed by Marathon Pipe Line Co., subsidiary of Ohio Oil Co., is queried from a dial station. Called a digital to audio translator accumulator (D.A.T.A.), device may be used with regular telephone facilities to transmit reports from remote pipe line points to a central office. Unit will be manufactured and distributed by Continental Technical Service Inc.

---

previously was assistant to the president.

Some of the instruments which will be manufactured include: A digital pH meter that will provide for discrete digit readings, eliminating the need for interpolation and possible operator error; chemical test equipment such as a titrator which is capable of performing all potentiometric and ampereometric titrations, and viscometers capable of measuring the molecular weights of polymers.

PROBLEMS of national scope in the field of automatic control will be discussed by a newly formed Associate Committee of the National Research Council in Canada. Chairman of the committee is **Dr. J. Ham**, professor of electrical engineering at the University of Toronto. The committee will coordinate university, industrial, and government interests in control theory and practice, and recommend general areas for Canadian research in automatic control.

SPOTLIGHTING PEOPLE

Gordon W. Smithson named chief engineer at Pratt & Whitney Co. Inc. . . . **E. Melvin Bellott** appointed assistant manufacturing manager of the lamp division at Westinghouse Electric Corp. . . . **Ralph B. Nottingham** promoted to assistant

Circle 666 on Page 19

Cleveland Speed Variator accurately controls paper web fed into Schriber Printing Press

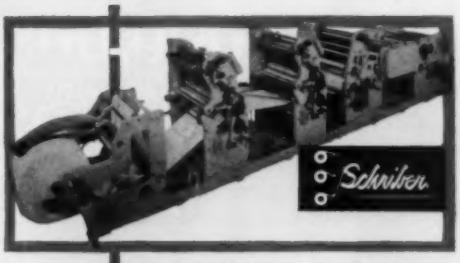
This new Rotary Offset Business Forms Press built by Schriber Press Company of Dayton, Ohio, was designed to provide printers with more hourly impressions—more daily output.

Its new infeed web tension control drive gives absolute constant tension from mill roll through a Cleveland Speed Variator-driven metering cylinder to press.

The Variator compensates for paper thickness—maintains constant surface speed of paper to the press—guarantees finished printing will always stay "in register".

A modified Cleveland Speed Variator providing increased precision within a limited (± 25%) range was selected for this important function. This was accomplished by changing the curve of Variator's iris plate. Thus, this Variator allows exacting adjustment for paper machine tension—holds that tension or can easily be changed to another speed setting.

If your operations demand speed variation, be sure to get the complete "Cleveland Speed Variator Story". It's all in free Bulletin K-200 —write for your personal copy today.



HOW IT WORKS

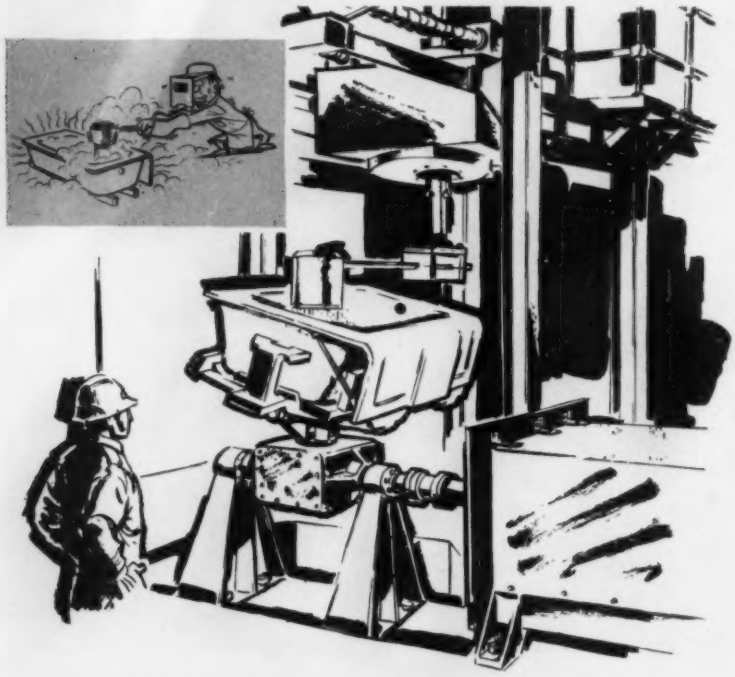
Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, left).

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3265 East 80th Street • Cleveland 4, Ohio

CLEVELAND SPEED VARIATOR

Circle 667 on Page 19

New twists in programmed manipulation from General Mills



BEAT THE HEAT! Mechanical Arm effects "cool" cost savings on hot castings

Now there's a way to free workers of drudgery, danger and boredom inherent in many industrial tasks... *and* save you money! Plumbing fixture manufacturing provides one example.

Cast iron bathtubs are generally enameled by sprinkling powdered glass on the 1750° heated castings. It has required the skill of master enamelers . . . using age-old manual techniques. It's mighty hard on men . . . and rejects are expensive. Today, a General Mills' Mechanical Arm coupled with an analog controller can perform the five simultaneous motions for uniform application of the enamel finish. Initial instructions are recorded on a plastic chart by manual operation of the master console. Thereafter, electronic playback duplicates hand enameling tirelessly and without human error.

General Mills' Mechanical Arms possess a unique blend of gargantuan strength and watchmaker's dexterity that's ideal for hard-to-handle jobs. Controller flexibility permits low-cost change of instructions for inline production at other stations . . . or switch to manual remote control.

Get the new booklet *Automatic Handling* for principles of programmed manipulation. Write: *General Mills, Nuclear Equipment Dept., 419 North Fifth Street, Minneapolis 1, Minnesota.*

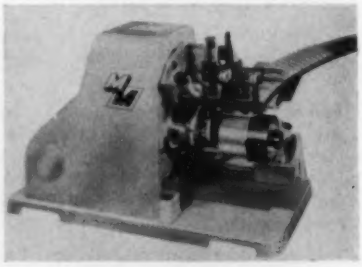
NUCLEAR EQUIPMENT DEPARTMENT

General Mills

First in Remote Handling

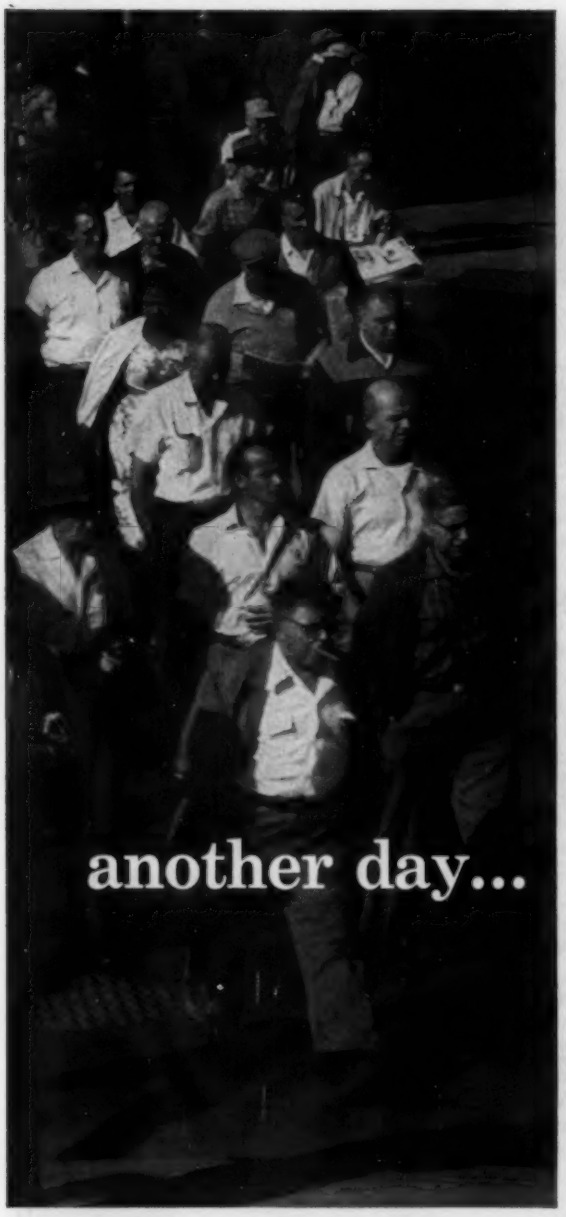
MECHANICAL ARMS

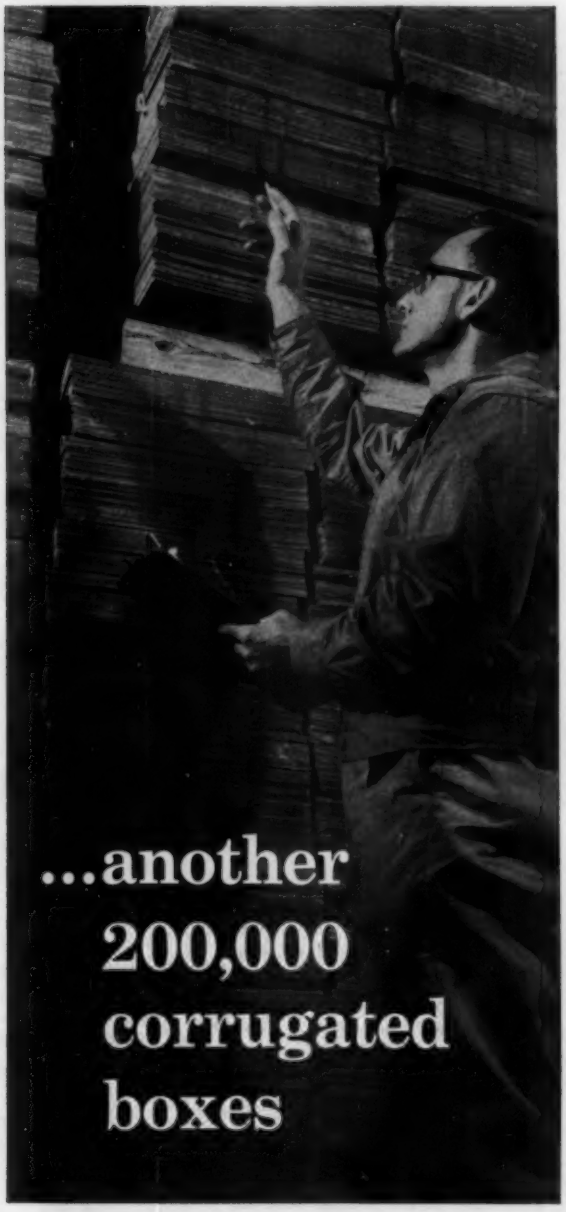
director of research at North Electric Co. . . . **William S. Aiken** named director of engineering at Thompson-Ramo-Wooldridge Products Co. . . . **Dr. Van W. Bearinger** appointed director of research and **Dr. John N. Dempsey** and **Edward E. Rexer** named assistant directors, all at Minneapolis-Honeywell Regulator Co. . . . **Robert L. Solnick** appointed chief project engineer of sample handling systems, Scientific and Process Instruments Div., Beckman Instruments Inc. . . . **John P. Macri** named manager of Custom Project Sales; **T. R. McKee** appointed manager of Data Handling Equipment; **J. Wesley Leas** named manager of Data Communications and Custom Projects Dept.; **Waldemar Saeger** appointed manager, Equipment Design, for the 601 Data Processing System; and **Charles M. Lewis** named manager of Industrial Computer Systems Dept., all in the Electronic Data Processing Div., Radio Corp. of America. . . . **Lyle A. Jakus** and **James C. Evans** appointed senior scientists of the newly formed systems laboratory at Hughes Aircraft Co. . . . **Richard E. Krengel** elected vice president and a member of the Board of Directors at Ex-Cell-O Corp. of Canada, Ltd. . . . **John G. Van Bosse** named supervisor of electronic switching systems design and development at Automatic Electric Laboratories. . . . **Milton Sanders** elected assistant vice



TAPERED TUBE imprinting machine developed by Markem Machine Co. can mark plastic, metal, and glass objects at speeds up to 100 per minute. Tapered objects up to 2¼ inches in diameter are automatically fed from a curved chute magazine into the self-contained printing mechanism, where imprints are applied. Flexibility of the machine allows for rapid type changing and adjustment for parts of different sizes. Inks are available with special drying characteristics and with resistance to handling, heat, and other environmental conditions.

Circle 668 on Page 19





In an eight-hour shift, Hinde & Dauch's Chicago plant (just one of seventeen) manufactures as many as 200,000 standard regular slotted boxes. This *volume capacity* is important to H & D customers. It assures them of a virtually limitless supply, a highly reliable source of the boxes they need for sustained production. After all, isn't this the kind of supplier support you'll be demanding during the competitive months to come?

Hinde & Dauch Division

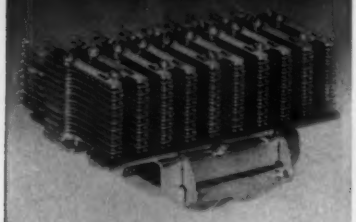
West Virginia Pulp and Paper

HINDE & DAUCH DIVISION, WEST VIRGINIA PULP AND PAPER, SANDUSKY, OHIO • 17 PLANTS • 42 SALES OFFICES

Circle 669 on Page 19

STROMBERG-CARLSON

"BB" SERIES RELAYS



For your automation ...computing...control circuit applications... **"TELEPHONE QUALITY"** at an ordinary price

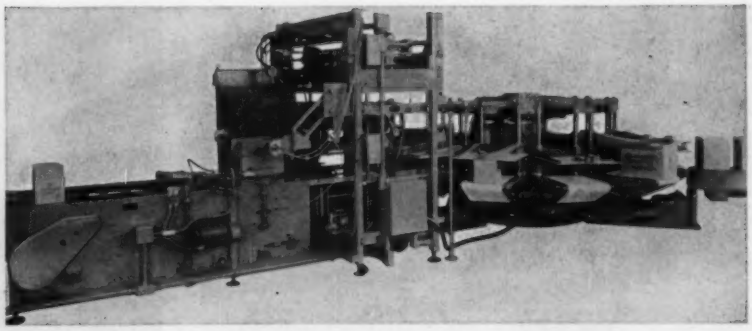
To meet your needs for precision and durability in automation, computing and control circuitry, here is *telephone quality* at an ordinary price.

The "BB" Series Relay accommodates up to 100 Form A spring combinations. It incorporates such important advantages as twin contacts, knife-edge pivot and special frame-armature construction. Like all Stromberg-Carlson relays, it is built to operate under extreme ranges of temperature and humidity. *Prompt delivery is available on all orders.*

For details, in Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HArrison 1-6618; Rochester: HUbbard 2-2200; San Francisco: OXford 7-3630. Or write to Telecommunication Industrial Sales, 111 Carlson Rd., Rochester 3, N. Y.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

Circle 670 on Page 19



AUTOMATIC case sealing line accepts cases of different dimensions in random order, seals them, and discharges them to multiple conveyors according to height. Major units in line include a flap gluing and folding device and a rotary sealing press that maintains compression on the tops and bottoms of cases to effect setting of glue. Sealing press can discharge cases to as many as five take-away conveyors. Line is a development of J. L. Ferguson Co.

president—engineering, at Teleregister Corp. . . . **H. J. Urbach** appointed director of engineering, and **Ralph E. McKelvey** promoted to assistant director of engineering, both at Timken Roller Bearing Co. . . . **John H. Nason** appointed manager of Commercial Development in the Research and Development Div., American Machine & Foundry Co. . . . **Dr. Ralph P. Johnson** named vice president, Electronics Div., Thompson Ramo Wooldridge Inc. . . . **James E. Hagget** named supervisor, Industrial Engineering Dept.; **Marshall W. Greene** appointed supervisor, Manufacturing Control Dept., crushing plants; and **Alan F. Howe** named supervisor, Process Engineering Dept., crushing plants; all departments of Norton Co. . . . **J. H. Powell** appointed manager of a newly created Materials Handling Dept., Chrysler Corp.

SPOTLIGHTING PLANTS

Litton Systems Inc. is the name of a new subsidiary recently formed by Litton Industries. The new company will engage in research, development, and production of defense equipment and systems activities. . . . **Bryant Computer Products** a former division of Bryant Chucking Grinder Co. has been made a full division of Ex-Cell-O Corp. . . . **Eastman Mfg. Co.** and **Imperial Brass Mfg. Co.** have approved in principle a proposal to merge the two companies. Terms of the merger will be submitted to shareholders of each company for final action. . . . **Robertshaw-Fulton Controls Co.** has announced expansion plans for its Grayson Controls Div. A new 10,000 sq ft wing will provide additional engineering space for the design, development, and testing of new control devices for the gas appliance industry. . . . **Magnetics Inc.** has announced the purchase of Kemco Corp., an industrial control panel manufacturer, which will become a subsidiary of Magnetics. . . . **Sola Electric Co.** has completed plans to move all operations from Chicago to suburban Elk Grove Village. The new plant will provide approximately 200,000 sq ft of floor space. . . . **Paratron Corp.** is the name of a new company which will conduct research in the fields of reliability investigations, specification and standardization studies, and testing, inspection, and quality control. . . . **Philco Corp.**, Lansdale Div., has established an Equipment Development and Manufacturing Operations group. Function of the new group will be to design, develop, and market specialized fabrication equipment for use in industrial areas such as semiconductor manufacture, tube manufacture, pharmaceutical and biological processing and metals, chemicals, and foods processing. . . . **DeVilbiss (Canada) Ltd.** has occupied a new factory addition at Barrie, Ont. This is the fourth expansion of the Canadian firm which produces atomizers, spray painting equipment, and air

compressor products. . . . Hill Acme Co. has purchased the entire product line of Kling Brothers Engineering Works of Chicago. Combination punch and shears, rotary shears, high speed friction saws, pyramid bending rolls, universal punches, angle bending rolls, and pinch plate rolls will be manufactured, distributed, and serviced from Hill's Cleveland plant.

MEETINGS AND EVENTS

Sept. 6-16—

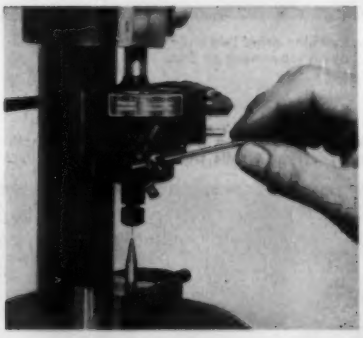
The Machine Tool Exposition—1960. Sponsored by National Machine Tool Builders' Association to be held International Amphitheatre, Chicago. Additional information available from association headquarters, 2139 Wisconsin Ave. N.W., Washington 7, D. C.

Sept. 6-16—

Production Engineering Show. Will be held Navy Pier, Chicago. More information available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Sept. 7-9—

Joint Automatic Control Conference. Cosponsored by ASME, AIChE, AIEE, IRE, and ISA to be held at Massachusetts Institute of



MINIATURE drill, designed by Milburn Machine Works, uses a high speed air turbine floated on air-oil bearings. The unit, which can be chucked in any standard drill press, jig borer, miller, or lathe, permits drilling of holes from 0.032 down to 0.001-inch in diameter. The air turbine that provides the drive develops speeds of approximately 1000 rpm per psi of air pressure, and in typical operation runs at speeds from 3500 to 120,000 rpm. Unit also incorporates pneumatic vertical feed that can be adjusted to suit drill size.

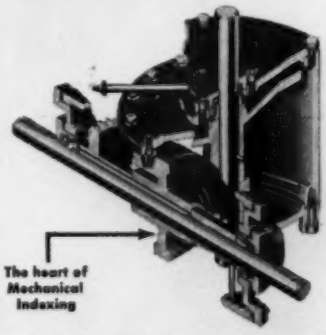
Why Index Mechanically

Important Features of Mechanical Transfer–

● SHOCK FREE TRANSFER OF MASSIVE LOADS

Made possible by cams designed and built to precise specifications to provide a high speed index or transfer motion with controlled acceleration and deceleration.

● ACCURACY OF INDEX



No other means provides such a high degree of precision repeatability of index. Regardless of number of positions accuracy is maintained. Transfer is never free—it is always contained by a tapered cam follower in the tapered cam path.

● SYNCHRONIZED TOOLING ACTUATION

Continued motion of the index cam shaft provides the power and basic motion for tooling actuation with positive mechanical interlock.

● INHERENT LOW MAINTENANCE

Standard Tool indexing equipment is practically maintenance-free due to its extreme precision manufacture and its carefully balanced components. Tapered roller bearings used throughout provide long durable service.

● TECHNICAL BOOKLETS

Fact-filled booklets showing indexing positions, tolerances, available dial and tooling plates, load ratings, dimensions and other information are available without cost. Standard Tool engineers will be pleased to assist you in selecting the indexing unit best suited to your particular requirements.

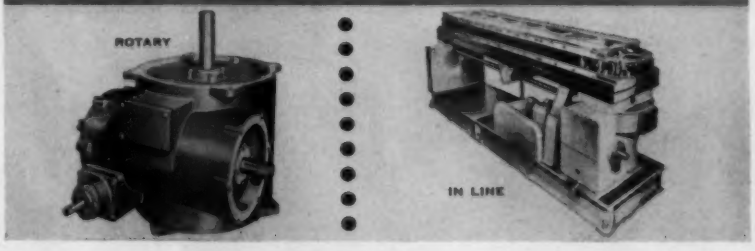
Better Products at Lower Costs thru Better Methods!

MACHINERY DIVISION

STANDARD TOOL & MANUFACTURING CO.

700 SCHUYLER AVENUE LYNDHURST, NEW JERSEY

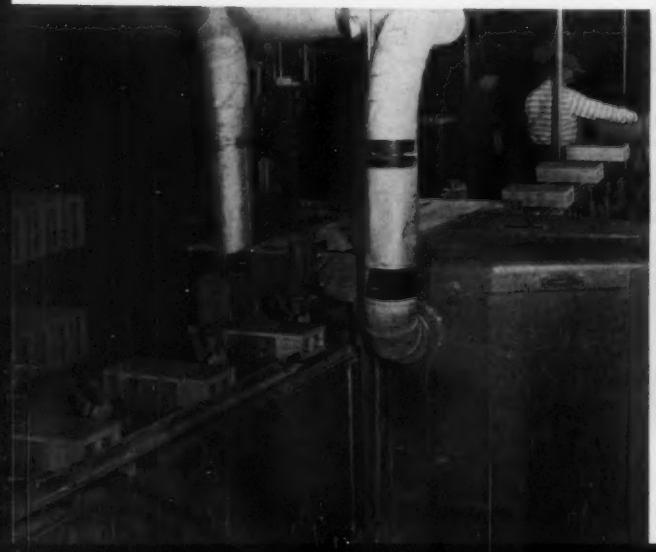
SELECT FROM A FULL RANGE OF UNITS—IN LINE OR ROTARY



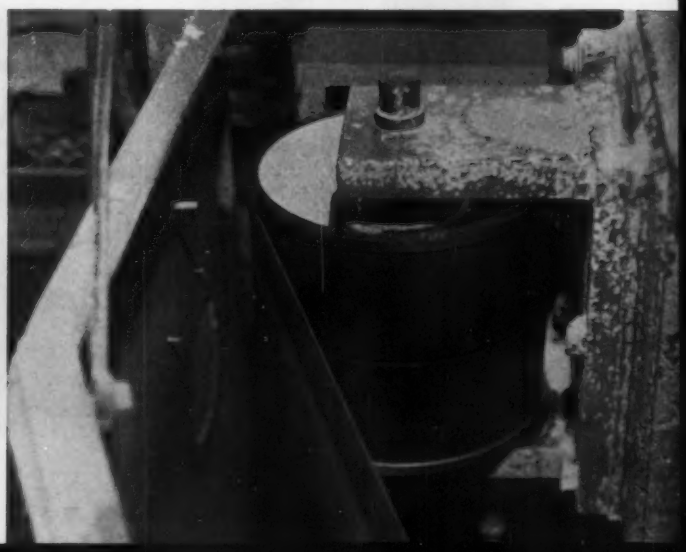
Circle 671 on Page 19

Tile being ground to a tolerance of $\frac{1}{16}$" in an overall length of 15¾". Two grinding heads staggered in same machine grind two ends in same pass. Due to planned oscillation, belt here is shown in lowest position of the cycle of the up and down movement on roll.

Tile production line showing automatic grinding machine equipped with LORIG-ALIGNER self-centering rolls to keep grinding belts perfectly aligned.



LORIG-ALIGNER self-centering rolls have a toeing-in action from both sides that keeps belt centered. Type 1 rolls were used on the sander.



This mark tells you a product is made of modern, dependable Steel.

Tile production boosted over 100% with belt grinders using LORIG-ALIGNER self-centering rolls

The Arketex Ceramic Corporation, Brazil, Indiana, produces load-bearing architectural tiles to within $\frac{1}{16}$" tolerance to the 15¾" overall length. Both ends are ground or sized *before* glazing and firing.

Mr. Ralph Weston, Vice President in charge of production, says, "Originally the production line required hand grinding and delivered 5 to 10 tiles a minute. This was too slow. Next, we installed two emery wheels facing each other across the production line. Output went up to 11 tiles per minute but this was still not enough to satisfy us. In our search for higher efficiency, we called in the Ryman Engineering Company of Pittsburgh, a licensee for LORIG-ALIGNER rolls. They recommended installing two belt grinding machines so that both ends of the tile could be ground automatically at the same time."

In designing the belt grinding machine, Ryman Engineering used LORIG-ALIGNER self-centering rolls to keep the belts in perfect alignment. Production jumped, labor costs were reduced. The savings are obvious.

As a matter of fact, belt alignment was so perfect after installation of the LORIG-ALIGNER rolls that it was possible to install an oscillating feature. In this way, the full grinding face of the belt could be utilized. Arketex was so pleased with the efficiency of this machine that they later so equipped two additional lines. Similar grinding equipment is now under study for other products.

LORIG-ALIGNER self-centering rolls with their built-in centering action also have hundreds of applications in industry where conveyor belts are used or where continuous sheets of material must be kept in positive alignment. Steel or rubber-covered rolls are both designed to supply this action. These are obtainable from licensees for LORIG-ALIGNER self-centering rolls whose names will be supplied on request. For more information, send the coupon.

USS and LORIG-ALIGNER are registered trademarks

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel

USS

Mr. Ralph H. Weston, Vice President in charge of production at Arketex, compares rough, unfinished tile (top) with stack of accurately ground tiles.

United States Steel
Room 6063, 525 William Penn Place
Pittsburgh 30, Pa.

Please send your booklet, "LORIG-ALIGNER Self-Centering Rolls" to:

Name _____

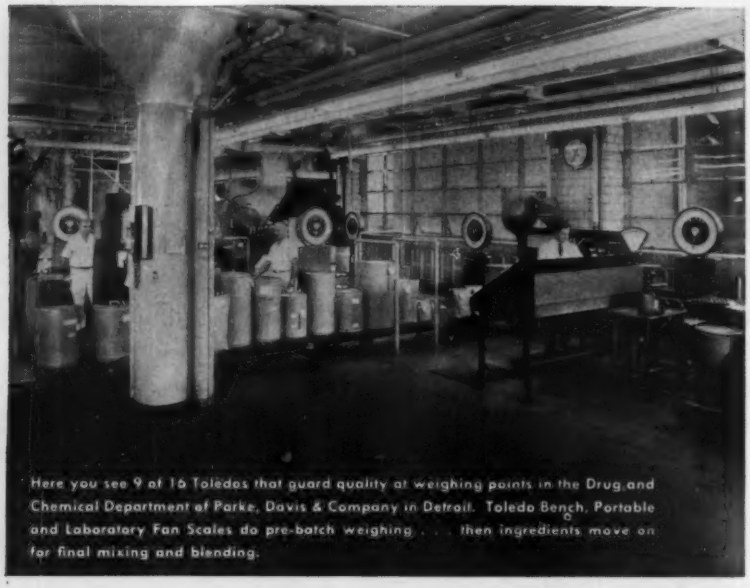
Title _____

Company _____

Address _____

City _____ Zone ____ State ____

(Please Print)



Here you see 9 of 16 Toledos that guard quality at weighing points in the Drug and Chemical Department of Parke, Davis & Company in Detroit. Toledo Bench, Portable and Laboratory Fan Scales do pre-batch weighing . . . then ingredients move on for final mixing and blending.

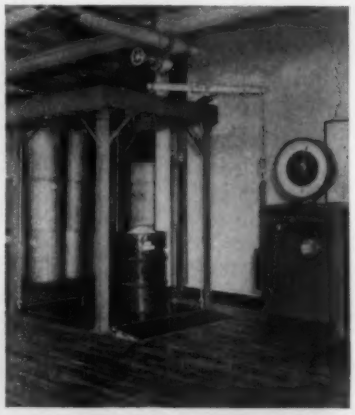
TOLEDO SCALES

meet PARKE, DAVIS & COMPANY'S *Critical Standards . . .*

Parke, Davis & Company brings to doctors and patients wonders in the world of medicine . . . products that help extend the span of human life . . . alleviate suffering . . . and thwart sickness and disease. It's a 94-year tradition at Parke, Davis & Company to keep going forward — in research and in methods and equipment used in their laboratories.

You'll see evidence of this company's progress in the choice of modern Toledos for fast, accurate control at weighing points. Putting Toledos in these vital jobs of weight-control assures that right amounts of drugs and chemicals go into each carefully determined formula — every time!

Let us show you how modern Toledos will fit your needs equally well — whatever your weighing problem. Write today for new Condensed Catalog 2001.



● Toledo Model 2282 Suspended Platform Scale weighs drug materials going into batches in the Crude Drug Milling Section of the Extract Department.

TOLEDO SCALE, TOLEDO 12, OHIO
Division of TOLEDO SCALE CORPORATION
(Toledo Scale Company of Canada, Ltd., Windsor, Ont.)

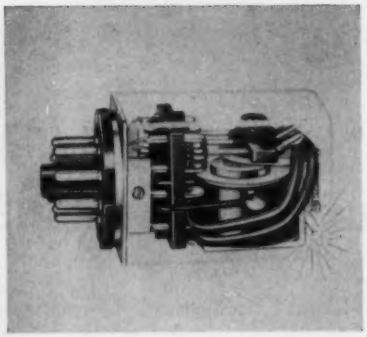
SERVICE factory-trained 240 Cities

TOLEDO

Weight-printing Scales • Motor Truck Scales • Automatic Batch Controls • Bulk Weighers • Automatic Check Weighers • Electronic Load Cell Scales • Counting Scales • Mailing and Parcel Post Scales

Headquarters for Weighing Systems

Circle 672 on Page 19



NEON LAMP is a feature of a plug-in relay developed by Guardian Electric Mfg. Co. The lamp is connected across the coil terminals of the relay and lights when the coil is energized. If the lamp remains dark after energization is applied, a circuit fault is indicated. Principal advantage of this feature is that it performs the function of a circuit tester.

Technology, Cambridge, Mass. For further information write Wm. D. Archibald, Energy Control Co., 5 Beekman St., New York 38, N. Y.

Sept. 7-15—

Coliseum Machinery Show. Scheduled for Coliseum, Chicago. Information is available from A. Byron Perkins & Associates, 2807 Sunset Blvd., Los Angeles 26, Calif.

Sept. 12-14—

Joint Industry Fall Meetings. The Material Handling Institute Inc., Industrial Truck Association, Monorail Manufacturers Association, Rack Manufacturers' Institute to meet at the Cavalier Club, Virginia Beach, Va. More information is available from Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

Sept. 12-15—

Society of Automotive Engineers. National farm, construction, and industrial machinery meeting, production forum, and engineering display to be held Milwaukee Auditorium, Milwaukee, Wis. Details are available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Sept. 13-15—

American Chemical Society. Chemical Exposition USA scheduled for Statler Hilton Hotel in New York in conjunction with 138th National Meeting of Ameri-

Louden Automation in Handling

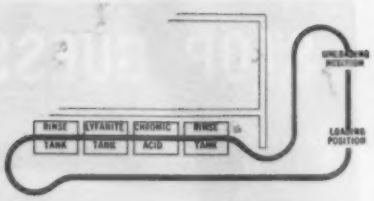
here pays for itself every eight months

As labor saving, cost saving and time saving become more and more important, automation and unattended operation gain equally in importance. Now, your materials handling can be automatic and completely unattended with a Louden Selectomatic-Automatic Dispatch System . . . further indication of Louden's ability to turn the many advantages of overhead handling to your greatest benefit.

The installation shown here is in the Johnson Motors, Waukegan, Illinois, outboard motor plant. Its function is to carry aluminum parts through a Lyfaniting (anti-corrosion) process. The moment its basket is loaded by one man and the button pushed, the Louden unit carries on by itself, dipping the basket contents into four tanks, one after another, for stipulated periods of time, and then delivering its load to a second man who unloads it. The Selectomatic-Automatic Dispatch System replaces a hand-operated monorail system and accomplishes in *one* shift what it used to take 3 shifts to do. On an initial investment of only $16,000, this user is saving in excess of $25,000 a year.

The Louden Selectomatic-Automatic Dispatch is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. When you have a materials handling problem or any plant problem involving lifting and transporting loads, call on a Louden engineering representative for suggestions. This will cost you nothing, but may well prove to be the most profitable action you have ever taken.

THE LOUDEN MACHINERY COMPANY
906 Broadway, Fairfield, Iowa
A Subsidiary of Mechanical Handling Systems Inc.



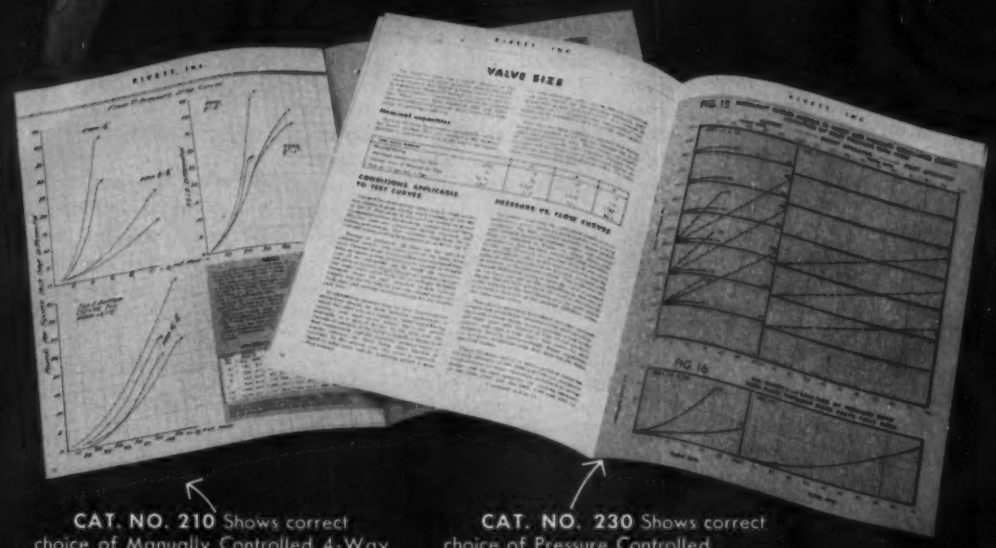
NEW...52 pages of illustrated applications . . . industry by industry. Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."

New! Louden Shok-Pruf Electrification for all monorail and crane installations. Hazards of open conductor bars now completely overcome by this exclusive Louden engineering development. Write for full details of this safe conductor system.

Louden
MONORAIL & CRANES
SINCE 1867..THE FIRST NAME IN MATERIALS HANDLING

Circle 673 on Page 19

STOP GUESSING VALVE PERFORMANCE!



CAT. NO. 210 Shows correct choice of Manually Controlled 4-Way Hydraulic Valves

CAT. NO. 230 Shows correct choice of Pressure Controlled Hydraulic Valves

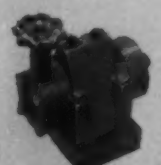
RIVETT Publishes The Facts So You Can Predict Accurately Pressure Drop In 4-Way and Pressure Controlled Hydraulic Valves!

Select your valves on facts, not guesses! The flow versus pressure drop curves shown in the catalogs above are based on actual tests. The curves make it possible to determine system efficiency and operating costs *before* you operate the circuit. Rivett's lower pressure drop means a lower cost to actually run your hydraulic systems. Before you specify the components for your next system, get the facts! Ask your Rivett dealer, or write for Rivett Catalogs 210, 230, 250 and 261 now.

RIVETT

Furnishes Complete Line of Hydraulic Valves — Over 400 Standard Models — 1500, 2000, 3000 P.S.I.—Sub-Plate and Pipe Mounted—¼" to 1½" Sizes—3 G.P.M. to 130 G.P.M.

FLOW CONTROL
Model 8622: 3000 P.S.I.; Sub-Plate Mounted. Four Sizes: ¼" to 1½". See Catalog 250.



PRESSURE CONTROL
Series 8800: Relief, Sequence, Unloading, Reducing, and Counterbalance. With and without check. See Catalog 230.

MANUAL CONTROL
Series 5000 and 6100: 4-Way. Hand, Foot, or Cam. Sub-plate or Pipe Mounted. ½" to 2" sizes. 2000 and 3000 P.S.I. See Catalog 210.

SOLENOID CONTROL
Series 6500 and 6600: 4-Way. Direct or Pilot operated. ½" to 1½" in three basic sizes. 3000 P.S.I. Low current. See Catalog 261.

PILOT CONTROL
Available in Solenoid, Pressure and Manual operations. ½" to 1½" sizes. 1500, 2000 and 3000 P.S.I.

RIVETT

RIVETT, Dept. AU-9, Brighton 35, Boston, Mass.
furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS
Member — National Fluid Power Association

can Chemical Society. More information available from ACS office, 1155 Sixteenth St. N.W., Washington 6, D. C.

Sept. 14-15—

Industrial Electronic Test Equipment Symposium. Sponsored jointly by the Office of the Director of Defense Research and Engineering and the Department of the Army, U. S. Army Signal Research and Development Agency. To be held at the Museum of Science and Industry, Chicago. Details available from Stanley I. Cohn, Armour Research Foundation, 35 West 33rd St., Chicago 16, Ill.

Sept. 15-16—

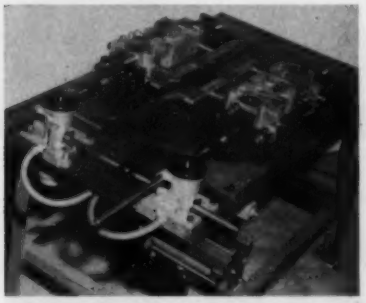
Engineering Management Conference. Sponsored by ASME, ASCE, AIME, AIEE, AIChE, IRE, AIIE, and EIC. To be held at Hotel Morrison, Chicago. Additional information available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 18-21—

Packaging Machinery Manufacturers Institute. Annual meeting to be held at Otsego Ski Club, Gaylord, Mich. Details are available from PMMI headquarters, 60 East 42nd St., New York 17, N. Y.

Sept. 21-22—

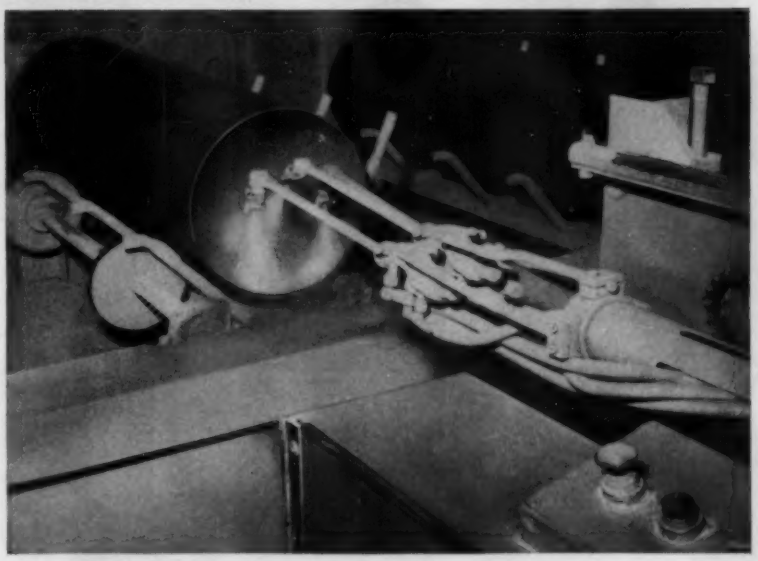
Industrial Electronics Symposium. Ninth annual national meeting co-sponsored by Institute of Radio Engineers and the American



TRANSFER UNIT for presses with relatively short strokes employs a single cylinder to actuate pickup fingers and advance workpieces through the press. Hydraulically or pneumatically operated device, developed by Livernois Engineering Co., employs a gear and rack principle for positive operation. Unit is protected against damage from mis-hits, and is available in a range of sizes.

At the new Day & Night Mfg. Co. plant...

Binks automatic spray system cuts cost...improves quality



Special automatic spray unit designed to give uniform coating to interior of water heater shells at Day & Night Mfg. Co., a division of Carrier Corporation, La Puente, California.

Installation of a Binks automatic spray system for applying porcelain enamel to water heater shells and flues has resulted in big savings for the Day & Night Mfg. Co., a division of the Carrier Corporation at La Puente, Calif.

The first unit of this expandable system spray finishes a daily volume that would require five times the number of operators and spray booths if done manually. A monitor at a control panel guides the entire operation. Fatigue is eliminated, coordination of spray guns and heater movement is precise, and the coating is far more uniform than by any other method.

Free planning service

If you would like to know ways to increase production or reduce costs in your finishing department, Binks engineers will survey your present setup and give you their recommendations *without obligation*. These men are specialists and have solved problems in thousands of plants making everything from golf balls to missiles. Chances are they have answers to the very problems you now face.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

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Binks
EVERYTHING FOR
CERAMIC FINISHING

SPRAY GUNS

SPRAY BOOTHS

NATIONWIDE SERVICE

Binks Manufacturing Company
3132-40 Carroll Ave., Chicago 12, Ill.

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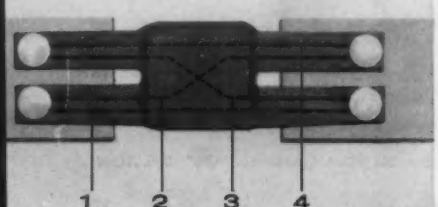
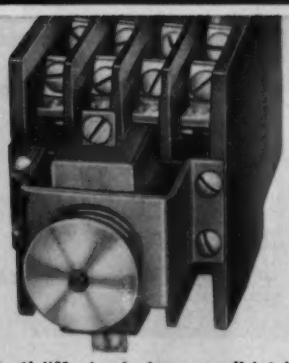
Another Cutler-Hammer first! Up to 24 poles in an area less than the size of a dollar bill.

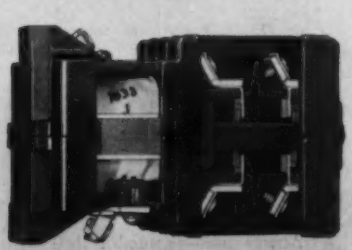
New contact reliability. Parallel bifurcated contacts, which allow four current paths instead of one, provide infinitely greater circuit reliability . . . liberally designed so any current path carries full relay rating.





At last! "Mechanical memory" latch as reliable as the relay itself! No adjustment ever needed. Add latch at any time.

New simplified design! Cutaway view shows basic simplicity. Coil vacuum impregnated to resist damage from humidity, vibration, electrical stress. Terminals can be screw or spade type.



Space savingest relay you've ever seen: New Cutler-Hammer "Compact 300"

Versatile 300 V. control relay is so reliable it's permanently sealed!

Here is the best answer yet to the need for an extremely reliable, small-size 300 V. industrial relay—the new Cutler-Hammer "Compact 300."

Every detail known that affects relay reliability has been improved in the "Compact 300." Bifurcated contacts which make possible *four* current paths rather than one, add millions of operations to the "Compact 300's" electrical reliability.

In fact, we're so confident of its electromechanical reliability, we permanently enclose the "Compact 300." And, if it should be damaged by a fault current, you throw it away and replace it with a new one. Its low price makes this an economical, practical maintenance procedure.

Now think of the space you can save with the "Compact 300." It controls up to eight circuits in panel space only 2" wide by 2¾" high. 2, 3, 4, 6 and 8 poles with any combination of N.O. or N.C. contacts are available, of course.

At any time, you can add "mechanical memory" latch with a life equal to the life of the relay. No adjustments are ever necessary. It's another exclusive! Better get full details on the new "Compact 300" now. Send for Pub. ED-L079-S283.

What's new at Cutler-Hammer? New, better products, like the 300 V. relay are coming steadily from our new, expanded plant facilities. We're ready now to help you take care of the great industrial growth of the future. If you are planning ahead and need electrical control assistance, contact the nearest Cutler-Hammer sales office.

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

Circle 676 on Page 19

O-M IMPROVED TIE-ROD HEAVY-DUTY HYDRAULIC (OIL) CYLINDERS 2000 PSI 3000 PSI NON-SHOCK MEET JIC STANDARDS BULLETIN 105A

MAINTAINING perfect piston rod alignment on thrust and return strokes is an engineering advantage of all O-M Air and Hydraulic Cylinders. But this is not the only reason why Design Engineers specify these components. For example, O-M Cylinders are all steel with bronze bearings . . . are cushioned to relieve piston shock . . . make full-power starts, and the length of each stroke can be held to the tolerance desired. In addition, O-M Cylinders can be mounted to deliver maximum performance in a horizontal, vertical or inclined position, and ports oriented to a convenient location.

These and many other advantages of O-M Cylinders are covered in our 1960 Bulletins with construction and dimensional details, engineering drawings, capacity chart and mounting data. For your copies, MAIL COUPON TODAY.

Bulletin 101A— Internal Key Tie-Rodless-Type Cylinders. Air 150 psi; Hydraulic up to 1500 psi.

Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders. Hydraulic 2000 psi; 3000 psi non-shock.

Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.

Bulletin 108—Automation (Heavy Duty) Hydraulic Cylinder—for 1000 psi operation.

All O-M Cylinders are available in 1½" to 8" bores with standard or heavy-duty rods. Complete line of mounts and interchangeable parts. Immediate delivery on most sizes. **MAIL COUPON TODAY**

ORTMAN-MILLER MACHINE COMPANY
25 143rd Street, Hammond, Indiana

Send Bulletins
☐ Have representative call ☐ 101A ☐ 105A ☐ 107 ☐ 108

Name_____ Position_____
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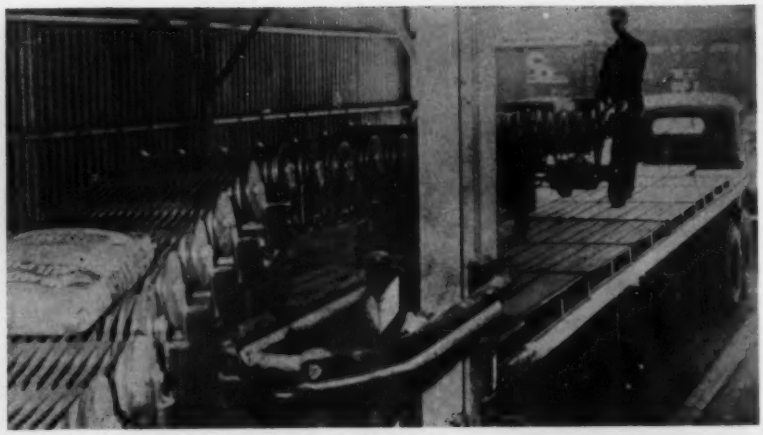
Circle 677 on Page 19



FLEXIBLE loader developed by Power-Curve Conveyor Co. enables one man to stack up to 500 bagged products on pallets in 30 minutes. In operation, pushbuttons control bag travel and direction, stacking height on pallets, and movement of the loader into and out of vehicles. An automatic gluing attachment may be used to improve the resistance of the load against shifting during transit. In loading a vehicle such as a box car or truck, two methods may be used. Pallets may be lined up against the walls of the vehicle and laid flat as loading progresses, or the pallets may be preplaced as in the illustration and the loader moved over the pallets to the proper positions. Any desired pattern of palletizing is possible with the device.

Institute of Electrical Engineers to be held at the Manger Hotel, Cleveland. More details from J. V. Werme, Bailey Meter Co., 29801 Euclid Ave., Wickliffe, Lake Co., Ohio.

Sept. 21-23—

American Management Association. Orientation seminar on organization and management of the manufacturing engineering function to be held La Salle Hotel, Chicago. Further details available from AMA, 1515 Broadway, New York 36, N. Y.

Sept. 25-28—

American Institute of Chemical Engineers. National meeting to be held Mayo Hotel, Tulsa, Okla. More information available from AIChE headquarters, 29 West 45th St., New York 36, N. Y.

Sept. 26-30—

Instrument Society of America. Fifteenth annual meeting and automation conference and exhibit, to be held at New York Coliseum, New York City. Additional information from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 27-30—

Association of Iron & Steel Engineers. Exposition and convention will be held at Cleveland Auditorium, Cleveland. More information from AISE headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

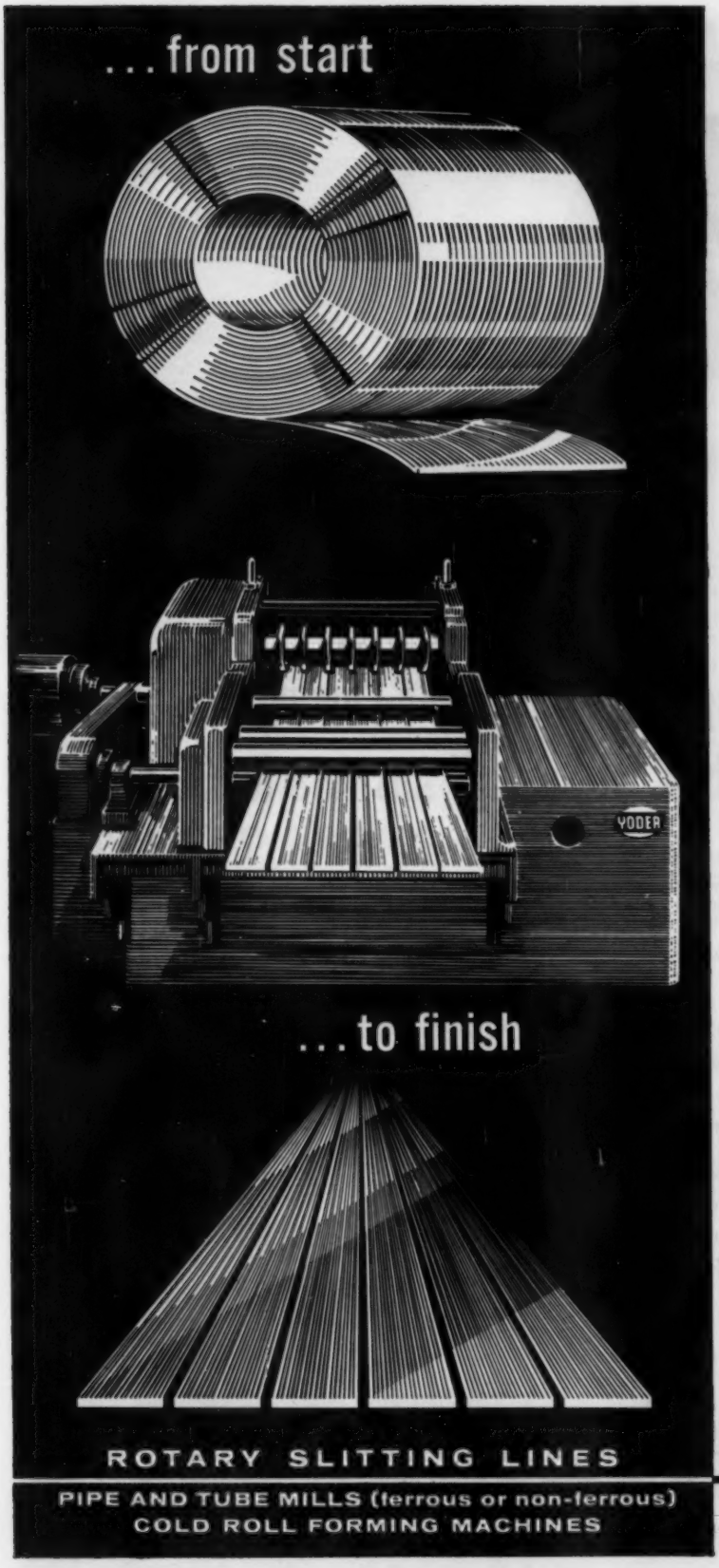
Oct. 3-7—

Southern Textile Exposition. To be held Textile Hall, Greenville, S. C. Additional information available from H. H. Lesesne, P. O. Box 1970, Columbia, S. C.

Oct. 5-6—

Electronic Industries Association. Second conference on value engineering has been rescheduled for Disneyland Hotel, Anaheim, Calif. More details available from EIA, Engineering Dept., 11 West 42nd St., New York 36, N. Y.

"Relief valves? Never use 'em!"



YODER ROTARY SLITTERS

If your slitting requirements call for coil widths from 12" to 60", in gauges from .015" to .250", the economy of purchasing Yoder Slitting Machinery can be yours. Operating a Yoder Slitting Line only one eight-hour shift per week, for example, could easily produce 35 tons of slit strands per week... or 1,820 tons every 52 weeks. At a slitting cost saving of only ½¢ per pound, the annual savings would amount to $18,200.

Additional savings can be realized through lowered inventory of mill-width coils—less waiting for delivery of special slit widths. Also, customer satisfaction will increase as you achieve faster completion and delivery of finished products.

At your request a Yoder sales engineer will study your plant operation to determine what equipment would most economically... and profitably... serve you, whether it be standard components or a completely specialized and engineered line.

Send for this illustrated text on slitting operations and equipment. It describes methods, time studies, operating cycles, material handling, and gives full specifications.

THE YODER COMPANY
5526 Walworth Ave. • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

Detrex Engineers Have Been Coming Up With "Cost Saving" Answers for 30 Years

Every metal cleaning operation has its own particular problems—but they're seldom new to the Detrex engineer. With 30 years of experience, he can produce the right formula to insure maximum productivity and economy in your operation.

He will analyze your product, the type of soil to be removed, the proper equipment and cleaning agent needed, the space and manpower required—every factor that bears on the problem.

When he gives you his recommendation, you can depend upon it to make sense—and save dollars. And when you put his recommendation into practice, you can depend upon Detrex to follow through with the finest service in the business.

Depend on DETREX for Every Metal Cleaning and Processing Need

- PERM-A-CLOR NA (Trichlorethylene)
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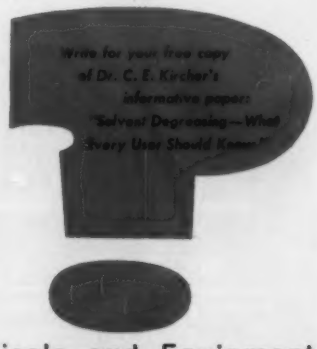
- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rustproofing Materials
- Extrusion and Drawing Compounds
- Spray Booth Compounds

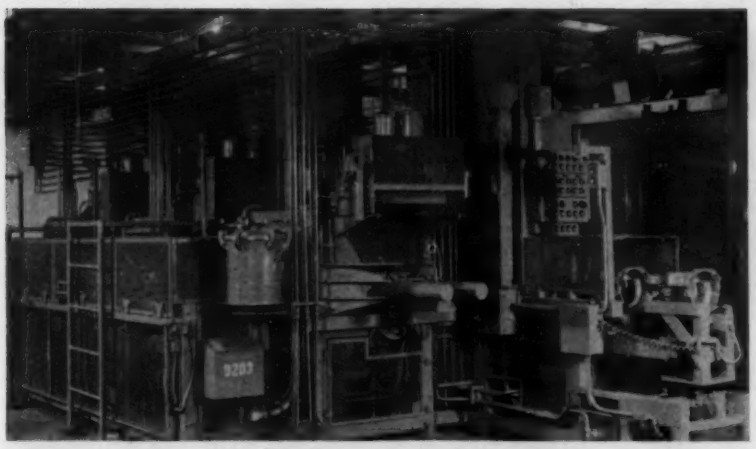


DETREX CHEMICAL INDUSTRIES, INC.

Box 501, Dept. A-960, Detroit 32, Michigan

World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

By JAMES C. KEEBLER Managing Editor



Dry-leak testing equipment is used by GM to check diecast aluminum transmission cases at the end of machining lines at Detroit Transmission Division. Three test stations each apply three tests to cases for 1961 model Hydra-Matic transmissions. Equipment was made by Cen-Tec Div., Centri-Spray Corp. Machine uses walking beam transfer mechanism to handle cases through the equipment. Full load is 34 cases. If input of cases stops, test unit will continue to cycle until all cases have passed through.

Finding the Leakers

"SIX MEN in a boat and the oars began to leak," is one of those old smart sayings of children that's bound to get a laugh every time. But when there's a leak suspected in the team effort at the leadership level, that's no laughing matter. The populace has come to expect the captain of the ship to be of impeccable character.

Sometimes the citizenry is woefully disappointed and the result of such sad news sets the organization image back a couple of notches. The climb up the ladder of leadership is best considered as one in which merit and achievement beget respect, and vice versa.

When certain labor leaders are shown to be suspicious financial characters the whole of organized labor suffers the loss of considerable face, and the rank-and-file who have honestly supported such leadership feel filched in more ways than one. Trouble sometimes seems to run in the family and some organizations get more than a fair share.

Troubled Waters

Chrysler has suffered from an over-abundance of woes. Untimely styling, sagged sales, and labor strife have been big obstacles. Yet the loyal employee who sees an upturn in these areas is pleased to believe that alert management is steering toward less troubled waters. Then comes another blow: Management action that seems to confirm a stockholder's accusation that all is not shipshape topside, and that some leaks in the profit hull are draining into the pockets of the brass.

What Is Propriety?

Widespread investigations that result from suspicions of skullduggery usually lead to reassessment of ethical standards. To what extent is it proper for an employee of one company to participate in the affairs of another company? Do different rules apply if the other company is a supplier, a customer, a competitor, or unrelated? Would it matter what degree of participation was involved; stockholder, director, officer, salaried employee, or relative? Must such participation be common knowledge, or may it be secret? Do different codes apply in different industries, companies, or departments?

These and many other questions may need clarification if an employee is to feel free to act and yet feel secure that he is within the bounds of propriety. One must be able to recognize what constitutes shallow ethical waters if he wishes to minimize the risk of going aground.

Defining the rules and finding the leakers is a responsibility of management, and all employees have an interest in such matters. Other types of profit leaks are the direct responsibility of various departments.

Need Checking

Manufacturing engineers must come up with cost-saving processes for it is their responsibility to keep manufacturing costs to a minimum. This must not be done at the expense of product quality. The use of automated production equipment makes a need for automated checking equipment.

Decisions as to where in the process to have inspection operations and how completely to check the workpiece at these stations must be made by the manufacturing engineer on the basis of his knowledge of the inherent capabilities of the various equipments involved and of the stakes and odds in the gamble to omit checking.

In acting as a control function, inspection facilities may provide the necessary measurement to facilitate setup and adjustment of operating equipment, or may be used to detect and signal malfunction. In the latter case, planning is aided by an ability to predict where trouble is likely to occur. Some feel that the whole subject is best

handled by personnel who are generally suspicious by nature. Those who are optimistic generally underplan for inspection stations.

Checking the Checker

Yet the overcautious approach can be costly. The old chief draftsman's answer for his dilemmas was: "Vhat vee need iss more sheckers to sheck da sheckers!" This philosophy can be applied to gaging operations and result in some extensive equipment requirements.

If the gage shows the workpiece is defective there is always a chance that the gage may have gone defective, and the reading be false. It may be advantageous to have checking circuits to check the checking circuits. The problem is where to call a halt.

Leak Testing

Checking castings for leaks is a good illustrative case, to show some of the problems that can be encountered.

If castings are checked before machining, the ones that leak then can be sorted out and the expense of machining those defective parts can be avoided. However, machining may uncover further defects. The only safe way to be sure that no leakers are assembled into the product is to check them after all machining is done. To detect damage that may occur during assembly (or faulty assembly) a leak test of the assembled mechanism may be in order. Yet if all previous leak testing is omitted, expensive disassembly and repair may be required because of defects that could have been detected earlier in the process.

The manufacturing engineer must decide how often and at what operations in the process to check for leaks. Factors that influence that decision include the costs incurred at the various steps of the process, the cost of inspection equipment, and the operating cost of such equipment.

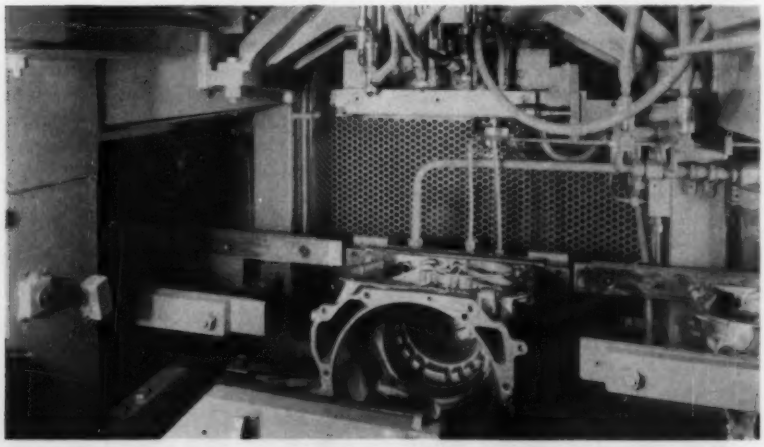
Corollary to the process considerations are the equipment design specifications. One of the newer techniques is dry-leak testing. This method uses differential pressure sensing cells to detect leakage and is intended to replace the method of pressurizing a sealed chamber with air, dunking the workpiece, and watching for bubbles. The dry-leak technique can be applied with either vacuum or pressure in the chamber being tested. The test specifications are usually correlated with the product designer, so that meaningful procedures and limits can be established for the test.

Automated Leak Testing

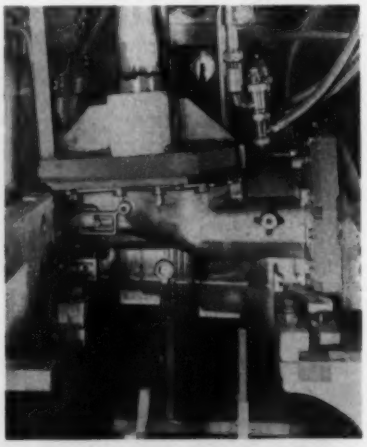
In the equipment pictured herewith leakage is determined by differential pressure sensing cells with two cavities. One serves as a reference cell. Connections from the other cavity are applied directly to the sealed workpiece. When pressure drops, a transducer triggers an electrical impulse which automatically actuates control panel lights and an ink marking device. Presence or absence of ink marks on workpieces emerging from the machine enable operator receiving parts at the outlet of the machine to sort out the leakers.

The control panel contains a counter that can be set for any given number of rejects. If that number is exceeded by consecutive rejections in a given station, an indicator lights, and that station is cut out of the system to be checked for equipment failure. Each test station can be manually checked against itself to see if the leak is in the air system or in the test chamber sealing mechanism.

Finding the leakers is a challenging problem whether it be profit leaks searched by top management or casting leaks detected by automated equipment.

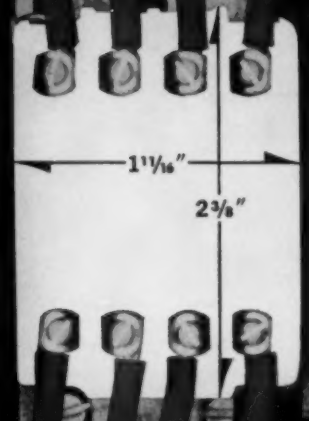


View of an open station on test stand at Detroit Transmission Division. Hydra-Matic transmission case is seen in position with sealing clamps drawn back. At this part of the cycle, hydraulically actuated mechanisms move in to close off all the openings in the case. Air is exhausted from the main cavity to establish test condition of 29 inches of vacuum. At the same time air pressure is applied to the accumulator bores (20 psi) and to the accumulator pressure passages (40 psi). If leakage occurs in any of these isolated chambers, a differential pressure sensing cell for that cavity will have a pressure change with respect to its reference cavity, and a transducer will initiate an electrical signal controlling an ink marking device. Test cycle takes approximately 45 seconds.



End view of closed test station with transmission case sealed off. Each station is like a separate machine with its own electrical panel and control systems, so one might be shut down while the others continue to operate. Separate hydraulic systems for each station are interconnected so that if one pump goes down the other two can keep the entire system operating.

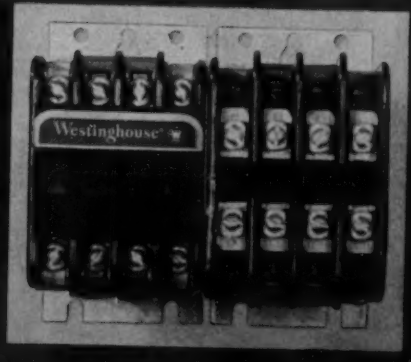
NEW MACHINE TOOL RELAY
cuts panel space



Actual size photo of machine tool panel

new machine tool relay cuts panel space 50%, reduces installed cost over 20%

ACTUAL SIZE



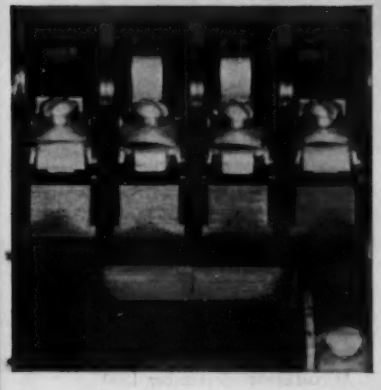
Machine tool relay is rated 6 amps, 300 volts a.c. from 2 to 8 poles in 2 basic frames. Relays can be butted against each other to save space.

Here's the new Westinghouse relay that cuts the control panel space requirements as much as 50%. Specifically designed for use on automated machine tools, this relay is smaller than any other similar unit available. Relays can be butted against each other in banks. What's more, both 4 and 8 pole frames have the same mounting dimensions, occupy the same panel area, and can be mounted adjacent to each other without additional electrical clearances. ■ Wiring a panel is easier, too. Relay terminals are all readily front accessible. Each of these clamp type connections has a wire stop . . . installation is faster and costs less. You actually save more than 20% over outdated relays. ■ This new relay has load rating of 6 amps, 300 volts a-c—found by experience to be ideal for most of the machine tools now being designed. ■ Want more information? Contact your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. Remember: You can be sure if it's Westinghouse.

See this relay in action on machine tools at the Production Engineering Show in Chicago—September 6 through 16.

Clamp type terminals are front accessible and will accept #14 to #18 stranded wire.

J-30318



Westinghouse

Circle 680 on Page 19

Longer Life! Superior Dependability!

THE ALLEN-BRADLEY LINE of BULLETIN 700 RELAYS IS COMPLETE!

TYPE B general purpose relay shown with 2 N.O. and 2 N.C. contacts. Made with up to 8 poles in various arrangements.

TYPE BX universal relay shown with 4 poles having both N.O. and N.C. contacts. Additional contacts on the 6 and 8 pole relays are N.O. only.

THESE IMPROVEMENTS ARE *IMPORTANT!*

These improved Bulletin 700 Type B and Type BX relays are establishing new standards for relay life and reliability. New design increases mechanical life by *at least 5 times* . . . a new contact motion insures *at least 10 times* greater electrical reliability. Double break, silver contacts never need maintenance, and the new molded coil is impervious to the most severe atmospheric conditions.

These new A-B relays—with their *extra millions of trouble free operations at no increase in price*—are a bargain in the relay field. Write for complete details, today.

A-B QUALITY

NEW ENCLOSURES

for the Bulletin 700 relays are styled by Brooks Stevens —internationally famous industrial designer. Note the "family" resemblance of these enclosures.

NEMA 1

NEMA Type 1 for general purpose applications with wrap-around cover for ready accessibility. It has a "quality" appearance.

NEMA 4

NEMA Type 4 enclosure for applications that require a watertight and weatherproof seal.

NEMA 7

NEMA Type 7 enclosure for NEC Class 1, Group D hazardous gas locations.

TYPE BR Bulletin 700 convertible contact relay shown with four poles. Made with up to six poles in line.

No other relay offers such simplicity in changing contacts from N.O. to N.C. (or vice versa)—it takes only 60 seconds!

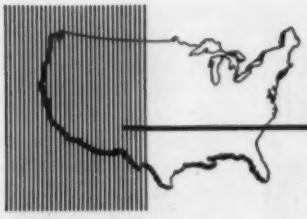
A four pole unit provides any of the contact combinations otherwise available only with five relays of the fixed contact type. You can reduce your relay inventories. In tests, this relay has *proved* it will provide many millions of trouble free operations. Double break, silver contacts never need servicing. Also, each relay can have one or two complete and fully rated contacts added to its base—in the field—without increasing space requirements. If you don't know about the Type BR relay, let's get acquainted.

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

QUALITY MOTOR CONTROL



western trends

CHECK sorters installed in the First National Bank of Arizona process checks at a rate of 750 per minute by reading coded data printed with magnetic ink. Unit in right foreground prints bank statements at rate of 900 lines per minute. This equipment is part of a recently installed computer-controlled data processing system which was developed by the Computer Dept., General Electric Co. Within the next five years banks all over the country will have to install similar equipment to process an expected volume of 22 billion checks per year.

Controlling the Flood

TWICE a month some of us sit down at our desks at home and tackle the problem of allocating a portion of the incoming paycheck to pay the current bills. In the course of this financial juggling, we write ten or more checks, place them in envelopes, and let Uncle Sam deliver them to our favored creditors. With a sigh of relief, we are happy to be finished with this chore for another two weeks.

In a similar manner, millions of other people all over the country add their contributions to a growing tide of checks that must be processed by about 14,000 banks in the United States. When the checks of the business world are added to this tide, they add up to a flood of about 12 billion checks per year. If this figure doesn't impress you, then consider that in the next five years this small flood of 12 billion checks will grow to a whopping 22 billion checks per year.

Handling this volume of checks adds up to a big headache for the banks of the country, especially since most operations have been manually performed up to now. For example, a branch bank may handle up to 22,000 checks per day and require approximately 30 to 35 hours just to manually sort this volume. Large metropolitan banks may handle as many as 500,000 to a million checks a day, and it's almost impossible to handle this volume efficiently by manual methods.

However, the American Bankers Association and the manufacturers of business machines have not been sitting back twiddling their thumbs as more people have been writing more checks. Instead, they have faced the situation squarely and have turned to automated data processing as the only answer to their problem. The key to their solution is Magnetic Ink Character Recognition (MICR) which has been approved by the ABA as a standard for automatic check processing.

MICR opened the door to more than just check sorting. It provided the means of converting all bank bookkeeping from a manual to an electronically controlled system. Although primarily developed as a data processing technique for banks, MICR is gradually spreading to handle data processing tasks for other types of commercial enterprises. One of these days, it could become the basis for fast and accurate data handling between the production line and front office.

One of the most recent banks to convert to MICR electronic data processing is the First National Bank of Arizona in Phoenix, Ariz. This bank is the second one in the nation to switch to a computer-controlled electronic data processing system using the MICR technique. First honors go to the Bank of America in California which began operation of a similar system ten months ago.

In preparation for the switchover, customers of the First National Bank were issued personal checks and deposit slips with their account number, bank branch, and other accounting information imprinted across the lower edge in magnetic ink. The ABA approved magnetic ink characters are readable both by eye and by machine. When a customer writes a check, he does it in the same manner as he formerly did under a manual accounting system. However, when the check

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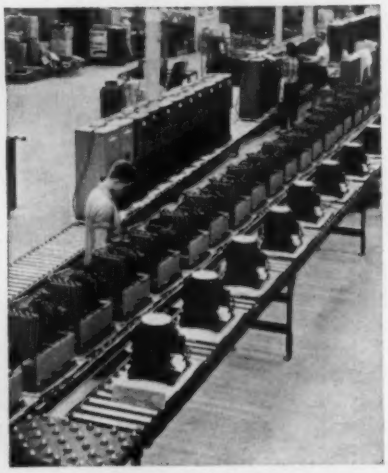

Gravity roller conveyors like this, used for Ebco's assembly lines, are inexpensive, easy to set up, and economical to maintain.

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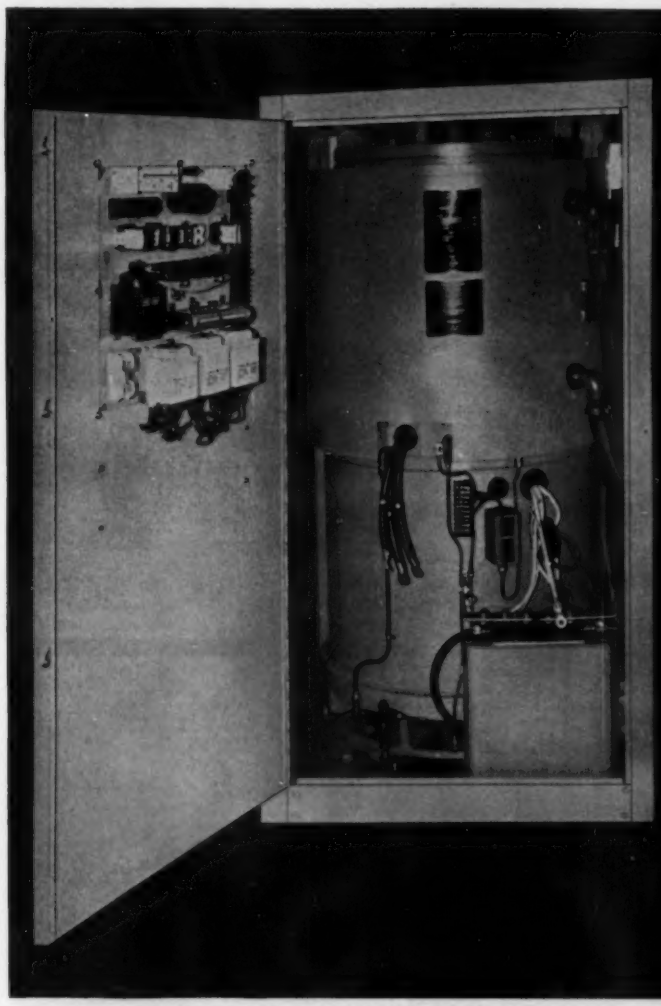
reaches the bank, the precision and speed of electronic data processing takes over.

First, since the check arrives at the bank mixed with checks from other banks, it is run through a sorter which separates the coded checks from the noncoded checks by reading the preprinted magnetic ink data. Then, during a proofing operation, the dollar amount specified by the customer is printed on the check with magnetic ink. From this point on, the check is handled automatically by a GE-210 data processing system developed by the Computer Dept., General Electric Co. In quick order, the following steps occur:

1. Check is fed through a document handler which reads the magnetic data on the check and transmits it to the computer to verify the accuracy of data.
2. Magnetic tape unit at computer sorts 30,000 digits per second to record information from checks in an account-number sequence.
3. Sorted information from tape unit goes to computer and is checked against information in customer's record while new balance in computer, and check amount, are entered in account file.
4. As customer account is posted, check is sorted on document handler and goes to customer file.
5. High-speed printer produces statement for customer, showing all transactions and current balance, either at end of month or on demand.
6. Cancelled checks and statements are sent to customer.

The system will sort and post 550 accounts per minute. By comparison, an efficient bookkeeper can sort and post about 245 accounts an hour. Since the installation will handle about 110,000 accounts, this means that once the proper information is fed into the system, the system can sort and post all these accounts in about 3½ hours.

Of course, only the large banks can use and need a computer-controlled data processing system. Small banks can still get maximum utilization out of Magnetic Ink Character Recognition by employing sorter-readers which sort checks and translate the coded information into punched card data for input into regular accounting machines. How much time will this save? Quite a bit for it has been estimated that as much as 30 to 40 per cent of a bank bookkeeper's time is spent in sorting and filing checks.



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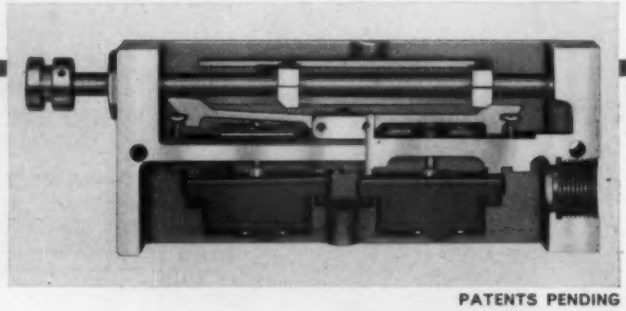

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Circle 685 on Page 19→

Turning Point

Significant not only as the pivotal year of industrial movement into automation, 1960 will record another important event. As the bellwether of the machine tool industry, the Machine Tool Exposition will usher in a new era in production machinery. Automatically programmed and numerically controlled equipment is taking the lead; the manually controlled production machine is becoming less in demand.

Tied in with the tremendous rise in special automated equipment, this year can be seen as a turning point in the traditional character of the industry. To keep pace, the industry will undergo some changes—new blood and a new sense of urgency to meet the needs of the times will be necessary. A broad new three-phase approach to automated manufacturing machinery must be developed in the years ahead to integrate the process, the handling, and the control aspects as a system. Engineering and research will become key essentials to the development of new automatic manufacturing processes. The values found in standard machinery of the past will be attained through new standardized techniques, methods, and elements applied to implement advanced concepts.

In an age of rapid scientific advancements of international scope, there will be no status quo. Success will require the will and ability to translate engineering knowledge and research into useful hardware for automated production. The real competition will lie in the practical application of manufacturing processes research.

The impact of the systems approach will be tremendous. It will create a new era in the history of the industry.

PUBLISHER-EDITOR

BASIC CONTROLLER FUNDAMENTALS

More and more people find general understanding of process controllers important to their manufacturing function even though they are not control specialists. Especially for these industrial people the author reviews fundamentals—What are the basic types of process controllers and their characteristics? For which kinds of applications are given types suitable? What factors are important in controller selection for specific jobs?

By **RENZO DALLIMONTI,** Section Head, Research Dept., Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

INDUSTRIAL controllers are devices that can automatically regulate the flow of energy to a dynamic process. They appear in great profusion particularly in the continuous processes of the chemical, metals, and petroleum industries. The process instrumentation diagram of a distillation column shown in *Fig.* 1 is an illustration of their many applications. Here, in one of the major steps in the refining of petroleum, they are found controlling a multiplicity of variables. They are universally used to control the common variables of temperature, pressure, flow, and liquid level.

Controller Characteristics

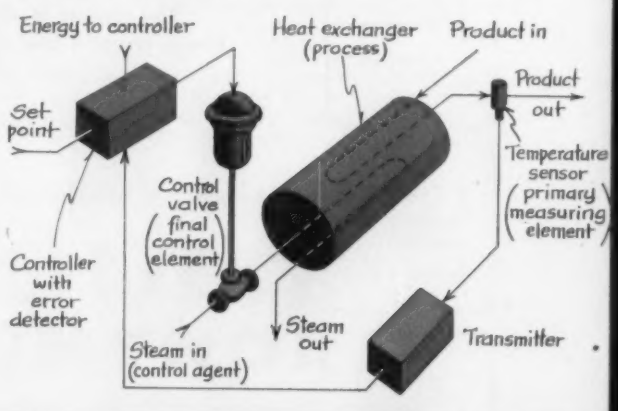
In the most general terms a controller is a device designed to respond to an input signal which is the measured error between a desired process condition and the condition actually existing. Controllers are used in feedback control systems such as that described in TABLE 1. Here the simple process of a heat exchanger illustrates essential components of the basic control loop. A schematic representation of the significant functions necessary for control is shown, too. An understanding of such simple control loops is important to the proper selection and application of controller types. While the terminology of control is not completely uniform, some terms generally accepted in the process industries are also summarized and defined in TABLE 1.

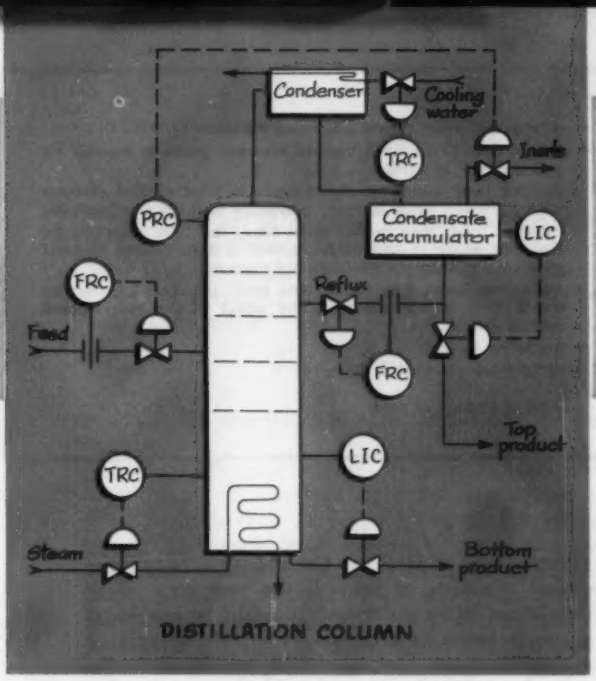
The controller is only one of the blocks that contributes to the dynamics of the system being created. However, since there is generally only limited freedom in establishing the characteristics of the process, it falls upon the controller to direct the forces that give stable plant operation. It must be understood, however, that system stability is the product of the dynamics of both controller and plant. A knowledge of both is necessary.

A satisfactorily running plant represents a balance of energies into and out of the process. As soon as a disturbance occurs to this energy balance an error appears between the process variable and

TABLE 1—Simple Control System Elements

A Simple Control System





KEY

PRC — Pressure Recorder Controller
TRC — Temperature Recorder Controller
FRC — Flow Recorder Controller
LIC — Level Indicator Controller

Fig. 1—Simple schematic diagram of a distillation column indicates that a variety and number of process controllers may be used on a single process step. Pressure, temperature, flow, and level are typical variables controlled in all types of industries.

the set point. The error is fed to the controller where it is interpreted through certain computation procedures designed into the device. The results of these computations determine the magnitude and dynamics of the controller output and, hence, the corrective action applied to the final control element.

The function which relates controller output to the input error defines the "mode of control." There are essentially five modes in general use today: 1. On-Off or Two-Position. 2. Proportional. 3. Proportional plus Integral (Reset Action). 4. Proportional plus Derivative (Rate Action). 5. Proportional plus Integral plus Derivative. The variety of possible control functions is limited only by human imagination and, therefore, these modes represent a selection of the most practical forms that have stood the test of experience. More complex forms are certainly found in industry today, but their added cost and complexity is only justified after it has been shown that the five common modes are inadequate.

Mathematical definitions have been derived, TABLE 2, which place control action on a scientific

Terminology of a Simple Control Loop

Control agent—That process energy or material of which the manipulated variable is a condition or characteristic.

Controller—A device which produces an output control signal as a function of an input error signal.

Controller output—Output control signal from the controller to final control element.

Disturbances—Changes in process conditions not initiated by the controller.

Error—Difference between set point and measured variable.

Error detector—An element, which may be integral with the controller proper or separate, that measures the difference between set point and measured variable and produces a signal proportional to error.

Final control element—A device which can be manipulated by the controller output signal to regulate the flow of energy or material to a process.

Manipulated variable—That quantity or condition which is varied by the controller so as to affect the value of the process variable.

Measured variable—A signal which is a measure of the process variable—generally the output of a measuring instrument.

Primary measuring element—A device which senses the value of the process variable.

Process—The collective functions performed in and by the equipment in which a variable is to be controlled.

Process variable—The process condition to be controlled.

Set point—The desired value of the process variable.

Transmitter—A device for transmitting the signal from the primary measuring element to another point.

General Control Loop Block Diagram

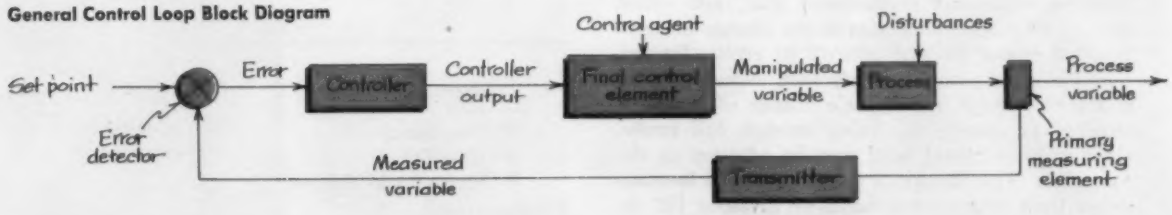


TABLE 2—Equations of Basic Controller Modes

CONTROL MODE	CONTROL EQUATION
On-Off (two-position)	$V = \text{Sign of } E$
Proportional	$V = KE + M$
Proportional + Reset	$V = KE + \frac{K}{T_i}\int E\,dt$
Proportional + Rate	$V = KE + KT_d\frac{dE}{dt} + M$
Proportional + Reset + Rate	$V = KE + \frac{K}{T_i}\int E\,dt + KT_d\frac{dE}{dt}$

KEY

E = error = Set point minus measured variable.

K = gain = change in final control element position caused by unit change in error.

M = manual reset constant; corresponds to final control element position when error is zero; generally manually adjustable.

T_i = integral time; also called reset time; the time required for the reset mode to add an increment in final control element position equal to the proportional response.

T_d = derivative time; also called rate time; the time interval by which rate action advances the effect of the proportional control action.

V = controller output.

dt = differential element of time.

$\frac{dE}{dt}$ = rate of change of error.

basis; however, the control modes of modern industry were historically developed through practical experience and intuition. The five modes in use today can be compared to the varying degrees of skill that a human operator might develop as he becomes more and more familiar with the behavior of a process he is controlling. We will review these modes in descriptive, graphical, and mathematical terms. In this review of basic modes it may be helpful to look at a controller simply as a "black box" that receives an error signal and generates outputs that are definite functions of this error. A valve is used as an example of a final control element in this discussion of basic modes.

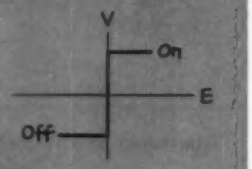
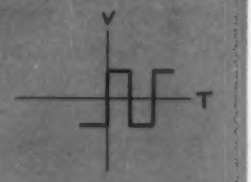
On-Off Control: This is undoubtedly the simplest and most obvious way to control. If the final control element is a valve and the variable is above the set point, turn the valve off; if the variable is below set point, turn the valve on. Thus, the function of error which is generated is an output sensitive to the sign of error. Since error is equal to the set point minus the measured variable, the error is negative when the measured variable is too high, and is positive when the measured variable is too low. For a valve controlling flow, the controller output will call for the valve to be closed when the error is negative, and open when the error is positive.

Proportional Control: The next step in controller sophistication is to position the valve in proportion to the size of the error. The larger the error, the wider the valve opening for instance. This leads to proportional control, a mode in which there is a continuous linear relation between values of the error and the controller output or valve position.

Mathematically, proportional control can be represented by the formula shown in TABLE 2. The factor *K* represents proportional gain, also called gain. The proportional gain is the change in valve position caused by unit change in error. Proportional band, a term commonly used instead of gain, is the percentage of full scale change of the error required to operate the valve through full stroke. Gain or proportional band may be adjusted on the controller. The amount of the gain, *K*, can be computed from proportional band by dividing 100 by the proportional band in per cent.

Proportional plus Reset Control: Continuing the natural evolution of control, the next step might come about in several ways. It might be concluded that it is better to keep the valve moving as long as there is error; in fact, the bigger the error the faster the valve should move. Mathematically this

TABLE 3—Response Graphs of Basic Controller Modes

	On-Off (two-position)
Steady State Relation To Error E = Error V = Controller output	
Response to Step Change in Error T = Time V = Controller output	
Response to Ramp Change in Error T = Time V = Controller output	Cannot be generalized
Frequency Response F = Frequency G = Gain (db) P = Phase Angle (degrees)	Cannot be generalized

can be expressed as:

$$\frac{dV}{dt} = \frac{K}{T_i} E$$

in which dV/dt is the rate of valve motion and T_i is the reset time, also called the integral time. Note that the position of the valve at any time is given by integrating this expression with respect to time. The result is:

$$V = \frac{K}{T_i} \int E dt$$

which is the characteristic equation for reset or integral action.

This equation shows why the mode is called integral control; it provides a correction proportional to the time integral of the error. However, this action cannot give very large immediate corrections for small errors following a disturbance, so it is well to retain some proportional action. By combining the two actions, proportional plus reset control is obtained which has the characteristic equation given in TABLE 2. Since the valve continues to move as long as there is error, a feature of the reset action, the combination of reset action with proportional action eliminates manual reset and the M term in the characteristic equation.

A proportional plus reset controller has two adjustments, K and T_i. K is defined as in straight proportional control. The integral action adjustment, T_i, is the *integral time*. Note that by virtue of the way the integral mode is defined in the characteristic equation, integral time is the time required for the reset mode to add an increment in valve position equal to the proportional response. This leads to an alternative term called *reset rate* which is the number of times per minute that the reset mode repeats the proportional response. Reset rate is, therefore, called *repeats per minute* and is the inverse of integral time. Controllers are calibrated in either term.

Proportional plus Rate Control: If error is increasing rapidly, more drastic valve corrections should be made than if error were changing more slowly. So we can make valve position proportional to rate of change of error. The expression for such rate control is:

$$V = KT_d \frac{dE}{dt}$$

where T_d is the rate time or derivative time. Combining this rate action with proportional action gives

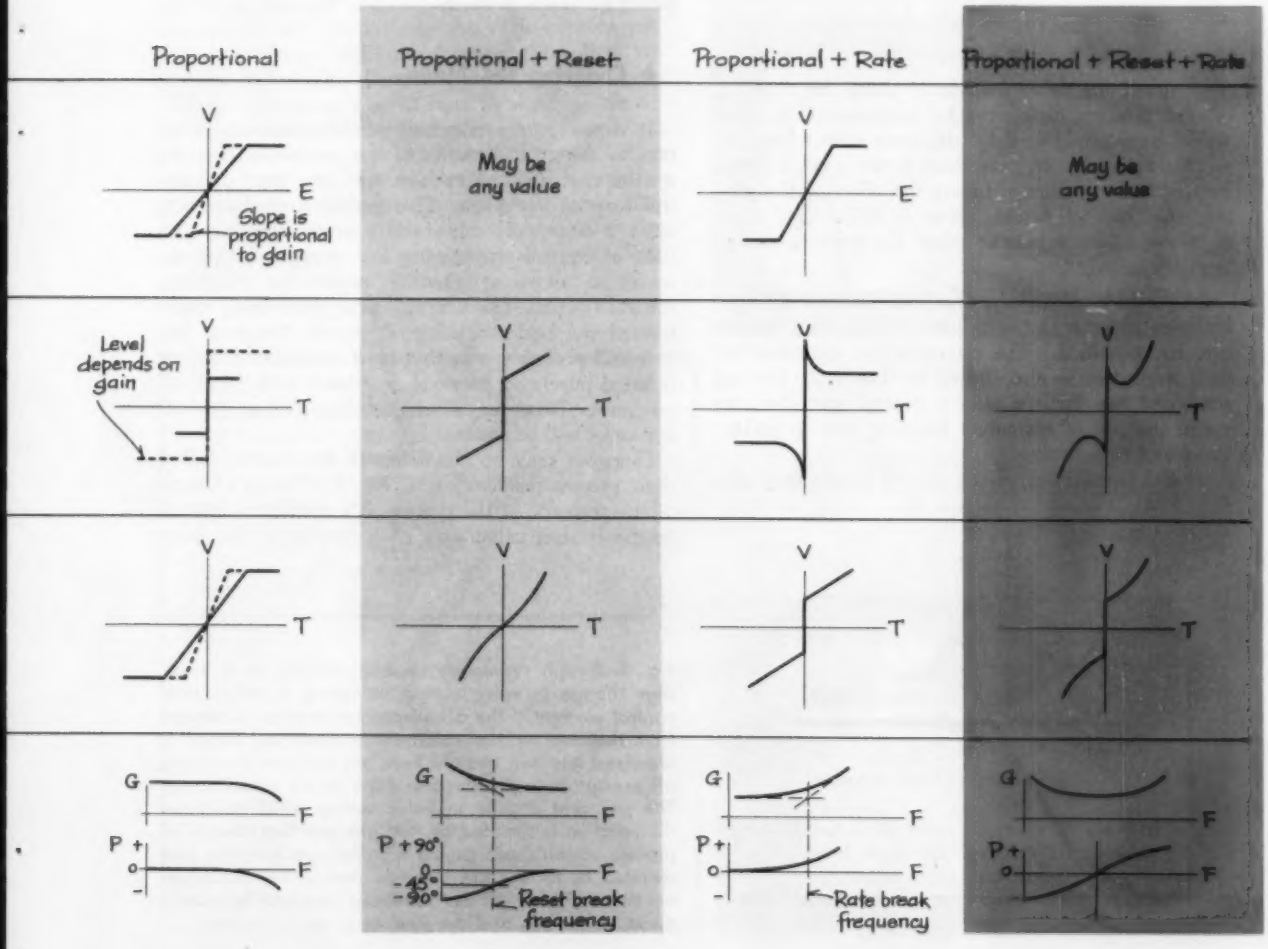


TABLE 4—Process Reaction Curves

Process	Process Variable	Per cent Valve Change ΔP	Reaction Rate R Per cent per min.	Lag L Minutes
Ammonia Absorber	Temperature	83	16	8.7
Fractionating Column	Temperature	42	6.3	7.5
Oil Tube Still	Temperature	25	8.2	3.1
Superheater	Temperature	25	24	2.1
Water Flow	Flow	33	47	0.12
Column Vent	Pressure	4	2.1	0.08
Canning Retort	Temperature	17	7.2	0.03

the characteristic equation for proportional plus rate control shown in TABLE 2.

The definition of the rate or derivative action is also bound up in a relation to the proportional response. A ramp input is often used to further define the rate effect. That is, let

$$E = ct$$

where c is a constant and t represents time. By substituting this expression for error, E, in the characteristic equation for proportional plus rate control and transposing the M term, we obtain

$$V - M = Kct + KcT_d$$

and

$$V - M = Kc[t + T_d]$$

This shows the valve position is ahead, by time T_d, of the position that straight proportional control would have established for the same error. In other words, derivative or rate time is the time interval by which rate action advances the effect of the proportional control action. Bear in mind that there is only a rate component when the error is changing with time.

Proportional plus Reset plus Rate Control: Finally, for even more sophisticated control all three modes can be combined. The characteristic equation for such a control is also shown in TABLE 2. Having combined the three modes, a control specialist can spend the rest of his career learning how to understand and tune them.

The characteristics of the control modes may also be defined in graphical form. These graphs are the responses of the controller modes to certain standard test signals. TABLE 3 is a summary of these responses. The modern method of frequency response analysis has been well explained in other literature and is a very useful method for determining the proper mode of control for a system. The technique requires a knowledge of the controller frequency response. This is nothing more than the steady state response of the controller to input sine waves of all frequencies. The characteristics given in TABLE 2 and 3 can be recognized as ideal. Real control hardware attempts to achieve such response, and pretty generally succeeds.

Choosing the Mode

It is the proper matching of the controller function to the characteristics of the process to be controlled that determines how well the over-all control loop will perform. This matching of characteristics is not easily done and a very extensive new field of control engineering has emerged in an attempt to arrive at scientific means for designing control systems. Considerable progress is being made toward the understanding of process dynamics but it is still probably true that most controller selection is based purely on previous experience with "similar" processes. However, a simple viewpoint of process dynamics will be useful.

Processes may be characterized by a curve called their process reaction curve, *Fig.* 2. This is a graph of the response of the process to a small step change in the control valve with no controller in the loop.

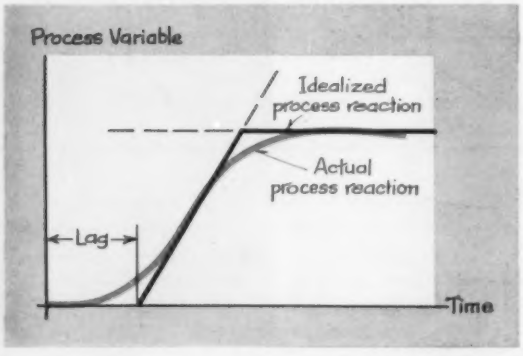


Fig. 2—Graph represents process reaction to a small step change in valve setting or setting of other final control element. The actual process reaction is plotted from response with no controller in the loop. Graph is idealized into two straight lines, the inclined one being an asymptote to the steepest slope of the actual curve. The per cent change in valve setting which produces the reaction is denoted as ΔP; the per cent change in process variable per minute is called reaction rate and denoted as R; the lag between start of the actual reaction and start of the idealized reaction is usually given in minutes and denoted as L.

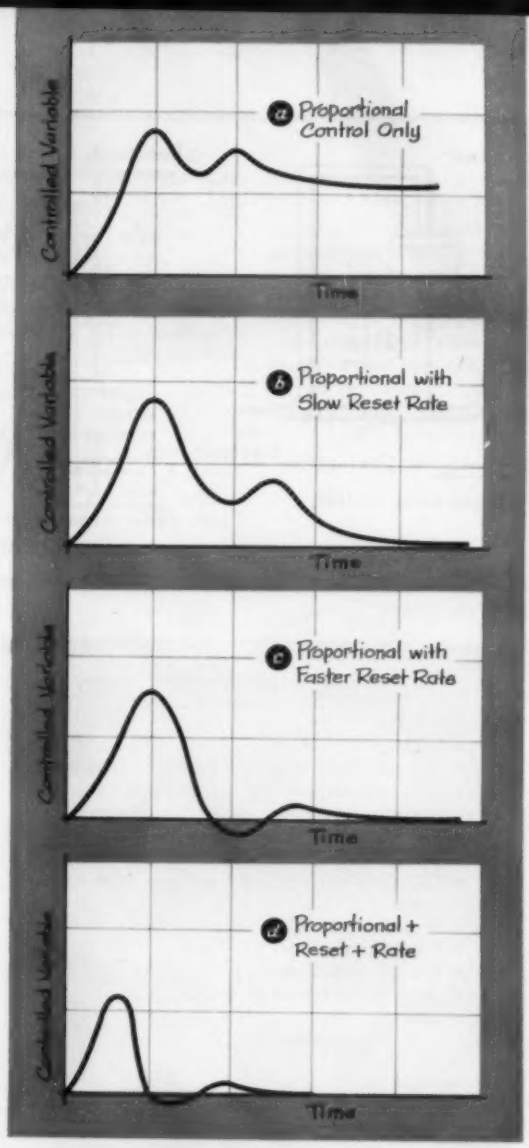


Fig. 3—Graphs indicate reaction of a controlled variable following a load change when different controllers are used. A controller applying only proportional control would give a result as in *(a)*; proportional plus slow reset as in *(b)*; proportional plus fast reset as in *(c)*; and proportional plus reset plus rate control as in *(d)*.

The reaction curve is idealized into two straight line portions as shown in *Fig.* 2. The delay portion is called the process lag and is the combined effect of dead times and small lags due to measurement, signal transmission, etc.; the sloping line is essentially a measure of the process reaction rate. It may be possible at times to make an analytical determination of this curve while at other times a simple test may be run. Knowledge of lag, L, and reaction rate, R, can be useful in selecting controller modes. Also, controllers may be adjusted for proportional band, reset, and rate using this information.

Many processes have been tested in this manner and a few of the values obtained are tabulated in TABLE 4. Since this is an approximate procedure, it will have its limitations, but it does give a qualitative feel for a process.

When Two-Position Control? This form of control is the simplest and usually the most economical, however, it is essentially cyclic. The process variable will always oscillate. All real controllers will have a differential, thus, the double amplitude of cycling must always be at least as wide as this differential. Controller differentials may vary from 0.1 per cent to several per cent of full scale. How much greater the cycling can get will depend on the number of process lags and dead time. Best results are obtained if there is one dominant lag, no dead time, and slow process reaction rate. Tem-

KEY

E = input error to controller
V = controller output to valve
G = high gain amplifier
A = input network transfer function
B = feedback network transfer function
X = output of input network
Y = output of feedback network
e = internal error to amplifier

$$X = EA$$
$$Y = VB$$
$$X - Y = e$$
$$V = Ge$$

If G becomes very large, then e approaches zero

As α limit $e \rightarrow 0$

$$X - Y \rightarrow 0$$
$$X = Y$$

Therefore $EA = VB$

$$\frac{\text{Controller output}}{\text{Input error}} = \frac{\text{Input network transfer function}}{\text{Feedback network transfer function}}$$

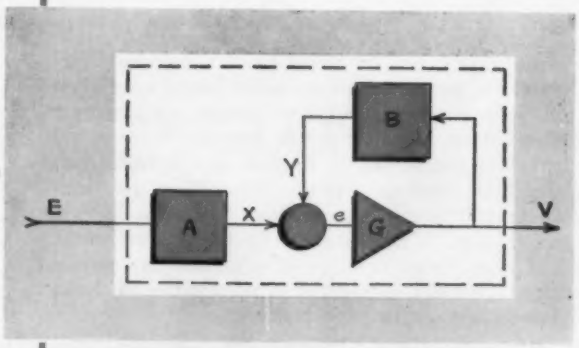


Fig. 4—Generalized block diagram of elements within a controller is basis for an expression relating controller output, error input, the transfer function of an internal input network, and the transfer function of an internal feedback network.

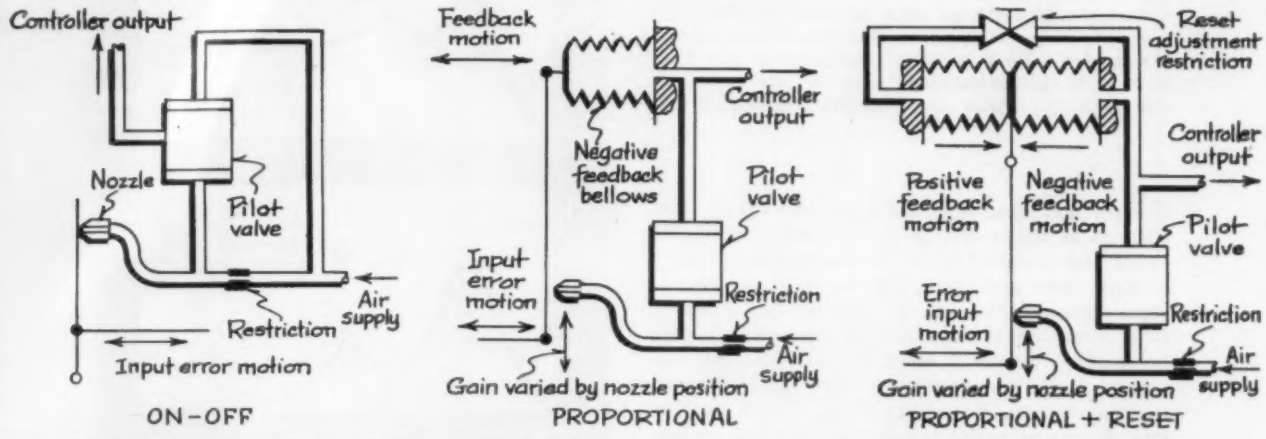


TABLE 5—Supplementary Factors in Controller Selection

- Cost
- What is the range of controller adjustments
- How simple are the switching facilities for going from manual to automatic control
- Ease of servicing and calibration
- Probable reliability
- Compatibility of signal forms with other equipment
- Long time stability or shift in offset
- Temperature shifts
- Cascading facilities
- General complexity of design
- Size
- Explosion proofing
- Weather proofing
- Mounting facilities
- Start up characteristics
- Saturation characteristics

perature processes are most apt to have these characteristics, hence, on-off control is found most often on such processes. A slow process reaction rate allows closer limits of control, but also increases the period of oscillation. If reaction rate is high, then very little dead time is tolerable. Thus, two-position control is satisfactory when: 1. Process reaction rate is slow. 2. Dead time and other lags are small. 3. Cyclic variation of process variable to several times controller differential is permissible. 4. Load changes are not large or frequent.

When Proportional Control? This mode can give control to almost any degree of stability. Each level of stability will correspond to a definite gain or proportional band. Processes with large capacity will have high gains and those with small capacity lower gains for the same degree of stability. The problem with proportional control arises from the basic nature of the mode as defined by its characteristic equation, TABLE 2.

If the process is operating at zero error, the valve must be at the position indicated by *M*. If a load change occurs, the valve must go to a new position. The equation shows that this can only happen by the deliberate introduction of steady state error, *E*. This error is called "offset" or "droop" and is a characteristic of proportional control action. The magnitude of offset depends on proportional band and gets smaller as the band gets smaller. Proportional control is most adequate when: 1. Large load changes are not present. 2. Small dead time and slow process reaction rate are involved. 3. Other transfer lags are small. If load changes are small, this mode will always result in close control.

When Reset Action? Proportional control alone produces an offset error if a load change occurs. In fact, an error as much as half of the proportional band is possible. If such errors are not tolerable, reset or integral action must be used. This mode ultimately can reduce the error to zero if the correction is within full scale of the final control element. *Fig.* 3*a* shows the control action following a load change with proportional control only. Notice that the variable lines out with an offset from the setpoint. If reset is added, the response will resemble Fig. 3*b* or 3c, depending on how much reset is used. In any event, error eventually is eliminated. The amount of reset needed will be related to the lags, dead time, and reaction rate of the process. Generally, fast processes with small capacity will use wider bands and fast reset rates. Flow control is a process that invariably will use wide bands (frequently more than 100 per cent) and rapid reset rates. Generally, a fast process, such as flow, will be mainly controlled by the reset action, while a slow process, such as temperature, will be mainly controlled by proportional action, with reset slowly wiping out the offset at steady state. It is reasonably safe to say that reset action will always be desirable, unless it is known that the percentage effect of

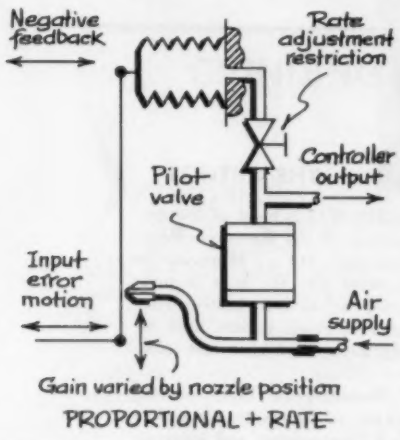


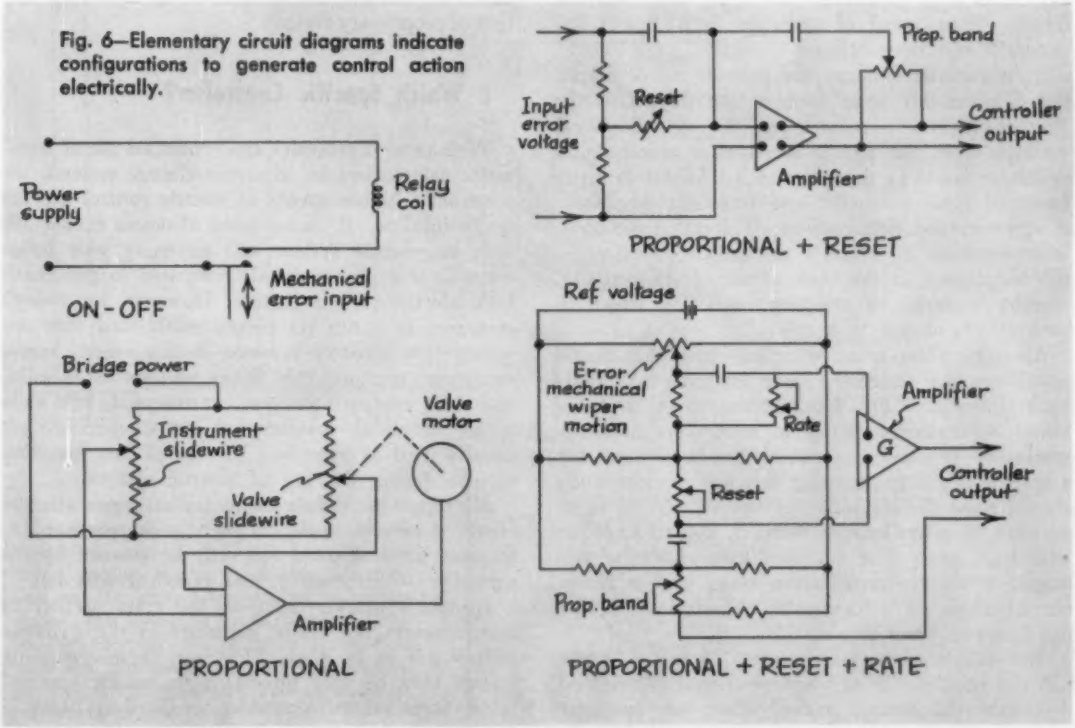
Fig. 5 — Sketches show common pneumatic arrangements for generating control action. A great many different proprietary designs are available, but most employ a variation of the flapper-nozzle concept.

load disturbances will not be severe or sustained very long.

When Rate Action? Whenever large transfer lags and large dead times are expected, rate action should improve control. Temperature processes will most often benefit because they are slow and have large lags, whereas flow processes cannot use rate action and may actually give considerably poorer results with such action. In theory, rate action should always give some improvement in reducing peak deviations and speeding up recovery. See *Fig.* 3*d* for typical comparison with reset only. In practice, because of continuously cycling disturbances it is not always possible to avoid frequencies whose effect rate action may exaggerate. Generally speaking, if a cyclic disturbance is expected rather than fixed load changes, be wary of rate action. In the final analysis, if you must have the tightest control you can get, try rate action, even if later it must be cut out due to excessive high frequency effects.

Use of All Three Modes: The best control is obtained when all three modes are used. Product

Fig. 6—Elementary circuit diagrams indicate configurations to generate control action electrically.



specifications may not always require such good control but the best insurance is obtained by selecting a three-mode controller. In practice, too little is generally known about the process and its disturbances to make a really well founded choice. Economically, it costs so little more to buy three modes than two modes that it may be cheaper to have the maximum control potential available for greater flexibility.

Forms of Control Hardware

Modern controllers exist which can receive and produce either hydraulic, pneumatic, or electrical signals. However, the basic control modes are independent of the device which produces them. That is, from a control function standpoint, it does not matter whether the hardware is pneumatic, hydraulic, or electric; whether it is force balance or deflection balance; or whether it is analog or digital.

Most controllers are either hydraulically, pneumatically, or electrically powered. In the process industries, control has been predominantly pneumatic, but a whole new generation of electronic controllers has appeared and it is quite probable that electric control may soon prevail. Since all controllers are attempting to generate the same mathematical functions, the various proprietary designs on the market essentially differ in their ingenuity of mechanizing the equations, and their attention to reliability, serviceability, ease of operation, and cost. Because pneumatic and electric controls are dominant, only the designs of these systems will be discussed. Hydraulic systems, while used, have been generally associated with applications requiring large working forces. Their speed of operation is high but has generally not been utilized.

In pneumatic systems, the gain device or amplifier is invariably some form of the flapper-nozzle. The electrical counterpart can be one of several varieties from the simple mechanical closure of a switch as found in the common thermostat to many forms of tube, magnetic, and transistor amplifiers. A very common electronic on-off circuit is the oscillator amplifier in which a mechanical input varies the inductance in the tank circuit of an oscillator, thereby initiating or stopping oscillation which in turn affects output to a relay.

All controllers more complex than the simple on-off type are designed around the same basic feedback philosophy. *Fig.* 4 is a schematic of the functional arrangement found in controllers presently marketed. While it may not always be obvious that a specific device is operating this way, a close study should show the similarity. There will be an input network, *A*, a feedback network, *B*, and an amplifier with high gain. The amplifier may appear in two stages, a signal amplification stage and a power output stage. The controller adjustments modify the values of *A* and *B*.

The function-generating systems, *A* and *B*, establish the relationship between error and output and determine the control modes. They are generally passive elements and therefore have a maximum of stability. Physically, they consist of pneumatic or electrical time delays, mechanical linkage ratios, diaphragm areas, springs, resistors, capacitors, etc.

Some of the common pneumatic and electrical schemes for generating control action are shown in *Fig.* 5 and 6. The emphasis is on basic circuit and hence no attempt has been made to review the details of proprietary designs.

THE AUTHOR

RENZO DALLIMONTI is head of the general research section of the Research Dept., Brown Instruments Div., Minneapolis-Honeywell Regulator Co. He is a lecturer on control theory at Brown Instruments' Instrumentation Education Center and before engineering groups of customer companies.

A native of Philadelphia, he graduated from the University of Pennsylvania with a BS in Mechanical Engineering and later returned for an MS in Electrical Engineering. After service in the Navy he joined General Electric Co. in Philadelphia. Then in 1948 he became affiliated with Brown Instruments Div.

Which Specific Controller?

With present processes and continued use of pneumatic valves even in otherwise electric systems, the potentially higher speeds of electric control are not really fulfilled. If transmission distances exceed 300 feet, an electric system will generally give better control. If a process is fast compared to pneumatic lags, electric will be better. However, for today's processes, it is not yet clearly established that one means is inherently superior to the other. Initial equipment cost presently favors pneumatics; installation cost comparisons are controversial but seem to be equivalent; maintenance cost comparisons are equally hard to come by. The use of data handling systems favors the use of electric systems.

All reputable industrial controllers approach the idealized control modes to such a degree that differences between them can only be assessed by the specialist. Consequently, the practical selection of a specific controller involves the consideration of many factors not really pertinent to the dynamic control job to be done. However, these remaining factors may be very important to specific applications. Some points to consider are listed in TABLE 5.

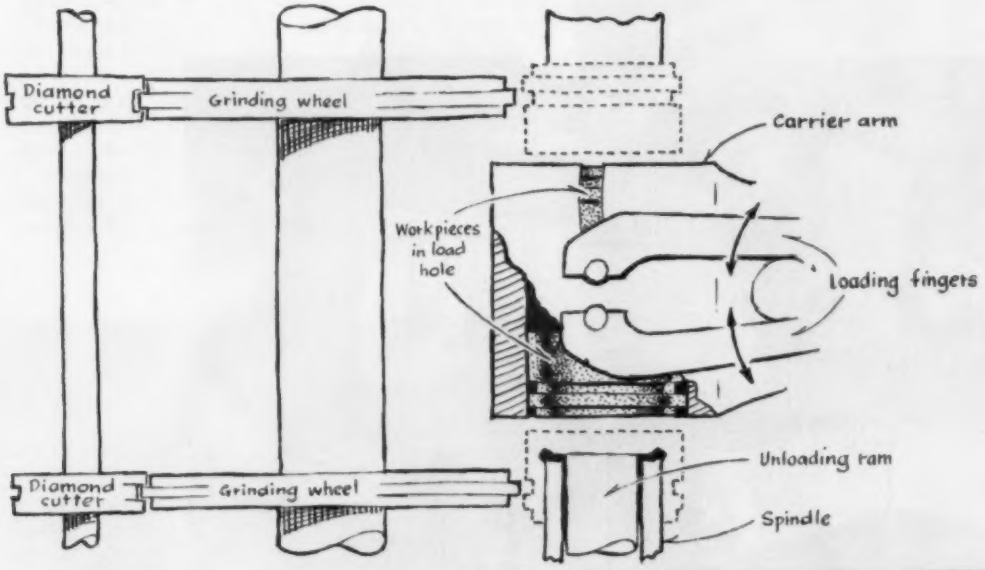
GRINDING EXTERNAL GROOVES AUTOMATICALLY

CONTINUOUS control of grinding wheel form and the use of automatic handling have made it possible to grind a ring groove on the O.D. of a hardened steel bushing at the rate of 2400 pieces per hour. Jones & Lamson Machine Co. has built a production grinder that attains this rate by using two wheels to grind two parts simultaneously.

An entire cycle—including loading, grinding, and unloading—takes just 3 seconds. Only one-half second of the cycle is nongrinding time. In this interval two pieces are unloaded from the spindles into the *Unload hole* in the *Carrier arm*, *Fig.* 1, and then the arm swings further so that two unfinished parts can be shoved onto the spindles from the *Load hole*. During the grinding portion of the cycle, the *Carrier arm* swings up so that the two finished pieces can be unloaded and two unfinished pieces loaded at the same time. The *Carrier arm* then returns to its position with the *Unload hole* between the two spindles.

The workpiece is 1.125 inches in diameter, and the ring groove in each must be $\frac{1}{8}$ inch wide and 0.40 inch deep. To accurately maintain these dimensions the grinder incorporates continuous automatic truing of the wheels. The wheels are trued by circular cutters made of thousands of cemented diamond particles in a metallic matrix. The contact surfaces of the cutters are motor driven in the same direction as the grinding wheel surfaces and at a high peripheral speed.

Resin-bonded wheels of medium grit and hardness have been used at peripheral speeds of 10,000 fpm to plunge grind the bushing grooves. At these speeds, up to 0.002 inch of stock can be removed for each revolution of the work. An oil coolant is applied at three points during the grinding operation—above and below the point of contact between the grinding wheel and the workpiece, and above the point of contact between the wheel and the diamond cutter.



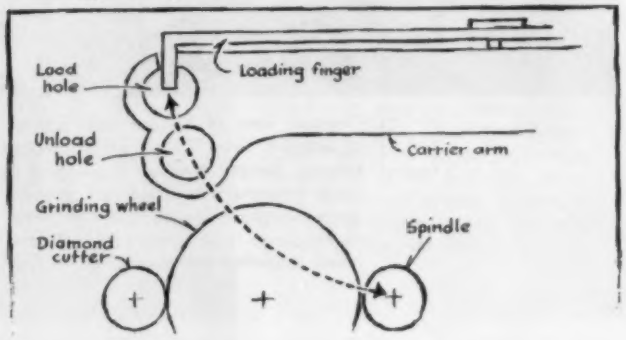


Fig. 1—Larger sketch shows plan view of major elements in grinder to automatically form ring grooves in 2400 bushings per hour; smaller sketch is a side elevation view of the same elements to a smaller scale. The swinging carrier arm simultaneously receives two finished parts then loads two unfinished parts on the spindles. The two grinding wheels are continuously dressed to proper form.

AUTOMATION TODAY

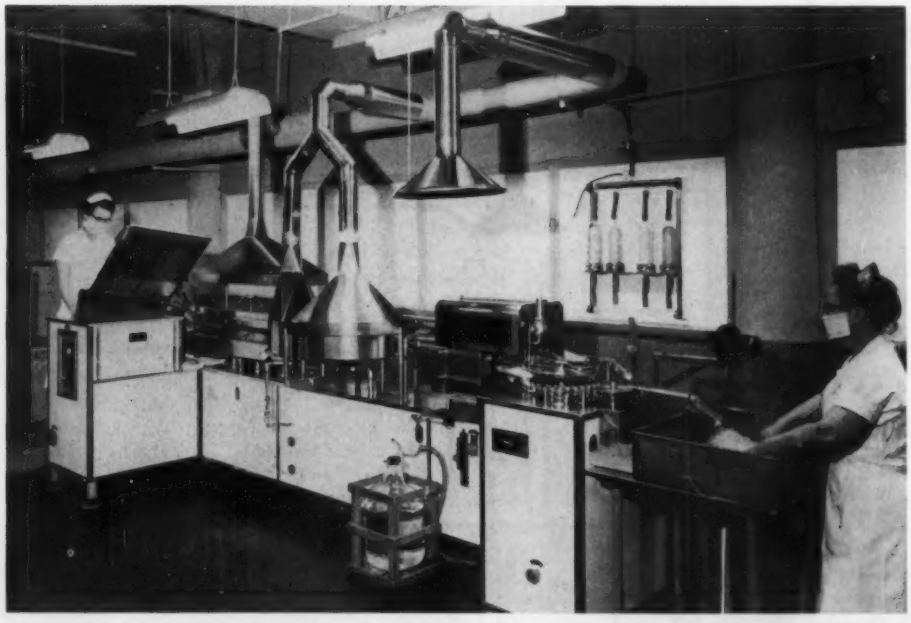
FILLING GLASS AMPULES

By **WALLACE HODES**, Secretary, Hodes-Lange Corp., North Bergen, N. J.

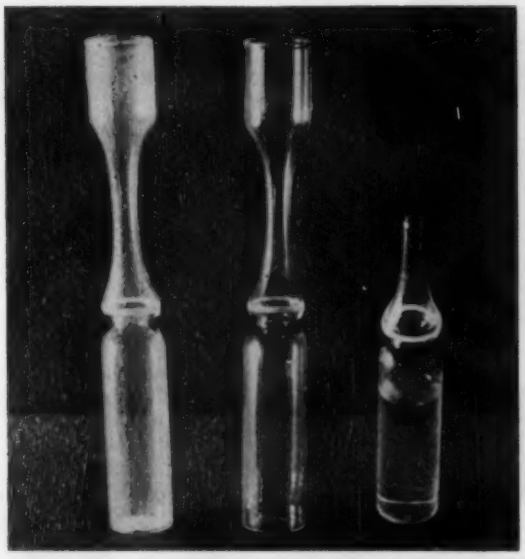
UNIQUE problems are encountered in the production of sealed glass ampules containing a single dose of injectable medicine. The main production stages are washing, sterilizing, filling, and sealing. As might be expected, the production problems are primarily concerned with how to process large quantities of the small ampules through the several production stages and still maintain the exacting cleanliness standards confronting the pharmaceutical industry.

The Hodes-Lange Corp., manufacturer of glass ampules, has designed and built a complete processing unit in which it is possible to mass handle ampules through the production stages. Winthrop Laboratories, Div. of Sterling Drug Co., was the first ethical drug manufacturer to put such processing units into use. The machine receives ampules directly from shipping boxes; removes cardboard dividers which separate the ampules into rows; feeds the ampules down a chute onto an endless notched conveyor belt; and carries the ampules through a rinsing, washing, sterilizing, cooling, filling, and sealing operation. The 12-foot long machine requires no human handling for the operations indicated, and is capable of processing ampules at the rate of 180 per minute.

Of general interest, ultrasonic cleaning equipment has been made an integral part of the processing



1 Over-all view of 12-foot long processing unit installed at Winthrop Laboratories, Div. of Sterling Drug Co. in which ampules are (left to right) received at machine in containers; passed through a washing operation; heated to destroy bacteria; cooled to room temperature; filled with proper dose of medicine; and sealed. Operator at left places empty ampules in the inclined hopper. Operator at right oversees output end of machine; metal tote-pan contains glass ampules that have just been sealed. Finished ampules are subjected to a dye test and subsequently packed for shipment.



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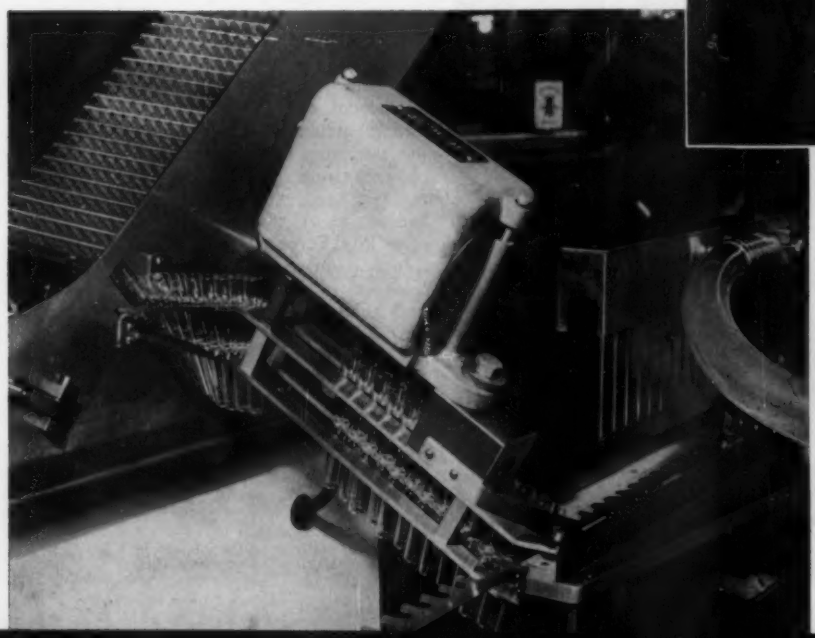
These ampules illustrate three stages in the production cycle. At the left is an ampule in the condition in which it is received at the processing unit. The condition of the first ampule should be compared to the middle ampule, which illustrates an ampule that has passed through the washing and rinse cycles. At the right is a filled ampule which has been heat sealed by fusing the opening. The white lines on the ampules indicate that the ampule can be broken open without filing the glass. Funnel shape of upper portion of open ampule provides a means of handling the glass objects.

unit. Two piezoelectric transducers are immersed in a tank of water beneath the washing section. The ultrasonic tank rises until water covers the lower 1/4 inch of the ampules, which are hanging from the notched conveyor belt. Concurrently with the immersion of the bottoms of the ampules in the ultrasonic tank, the ampules are being subjected to an interior cleaning action by a jet of water. Ultrasonic vibrations are readily transmitted through the glass to loosen all dirt particles on the inner walls of the ampules, and the particles are flushed out by the cleaning jets. The ultrasonic cleaning equipment is manufactured by Branson Ultrasonic Corp.

Details of the integrated washing, sterilizing, filling, and sealing operations are illustrated in the pictures accompanying this article.

3

Ampules are placed on inclined chute in batches of 300, open-end up. Neat rows of ampules are maintained by divider boards. As successive rows are picked off of bottom of the stack, divider boards are automatically discarded by the feeder.



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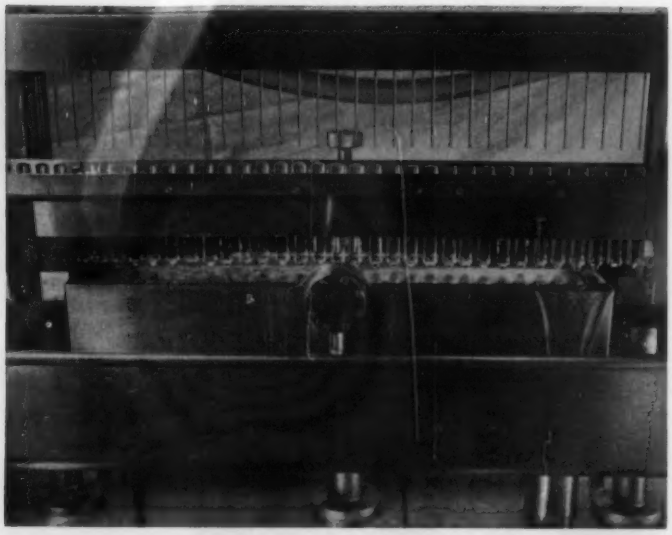
As shown here, rows of ampules from the hopper are pushed onto a chute leading to a notched, continuous conveyor belt. Funnel shape of upper portion of ampules enables the individual units to slide between rails that form the chute. The funnel shape also allows the units to be suspended in the notches of the conveyor belt. The series of vertical, tubular nozzles, right, marks the beginning of the washing section of the machine.



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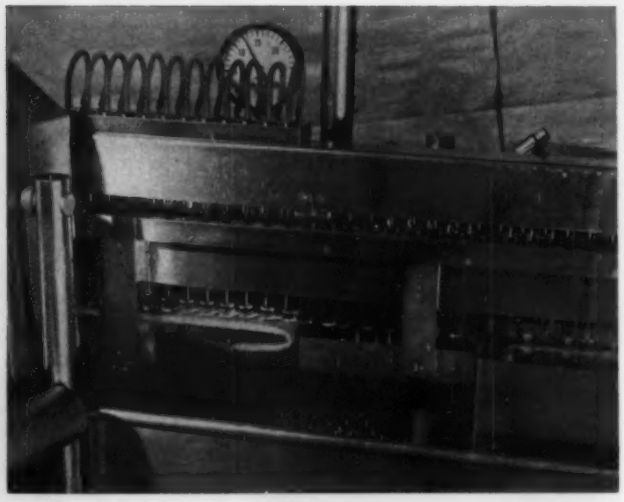
Washing portion of processing unit cycles so as to clean a batch of ampules hanging from the conveyor. When a batch is located over the cleaning tank (containing ultrasonic energy source) the tank rises to immerse the lower ¼ inch of the ampules. Simultaneously the tubular nozzles are lowered into the ampules and water under 30 psi pressure begins to rinse the insides of the ampules. Two 6-second ultrasonic cleaning cycles loosen minute particles that are subsequently flushed out by the rinse water.



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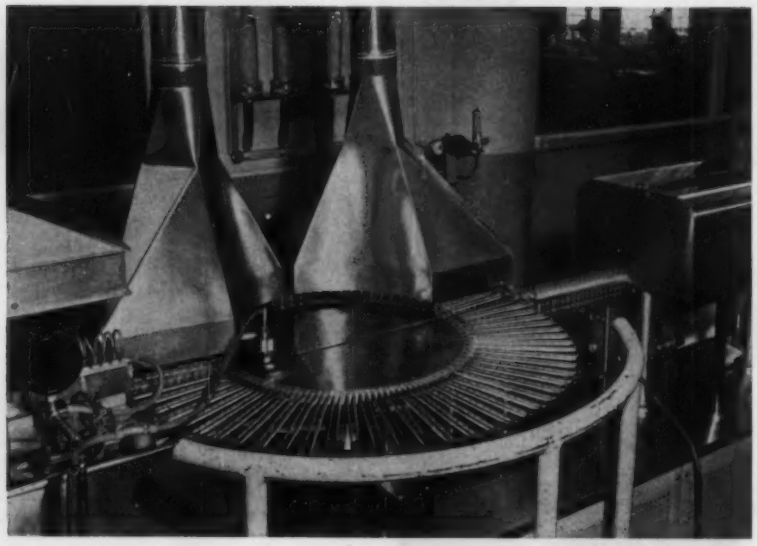
Following the washing and rinsing cycle, ampules are indexed into position beneath vacuum probes (left). Here water is extracted from the interior of the ampules; sponge-like arrangement below ampules removes drops of water that remain on the bottom of the containers.



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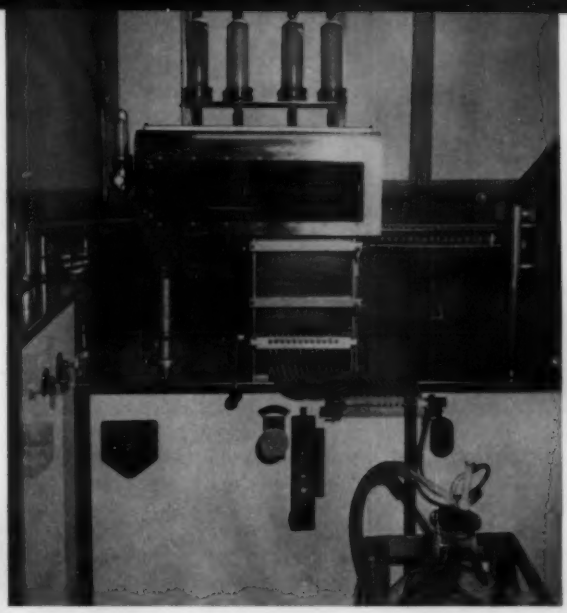
Batches of ampules are moved into a circular index table for the sterilizing and cooling part of processing cycle. Beneath the left hood, the ampules are heated to a glowing orange color (900 F), just below the distortion point of the glass. This removes all residual moisture and renders the ampules surgically sterile. Beneath the right hood, the ampules are cooled to room temperature. Subsequently, ampules are transferred back to the notched conveyor belt. At the right, a line of ampules are shown entering the filling section of the processing unit.



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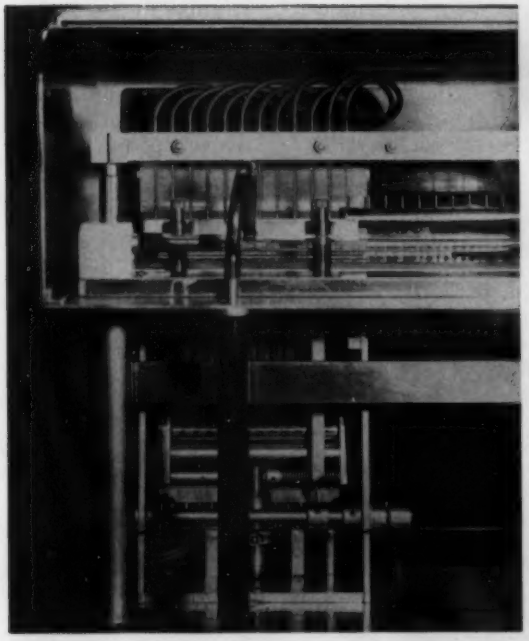
Exterior view of filling section of processing unit shows how solution in large glass container is fed into the unit. Entire filling tube harness and manifold can be replaced in a matter of a few minutes when a different medicine is to be filled into the ampules.



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The filling operation takes place within a protective hood (shown here with side cover removed). An ultraviolet light ensures a sterile atmosphere, and when required, a nitrogen atmosphere can be introduced within the hood as a further protective measure. The filling needles are precisely located relative to the centers of the funnels of the ampules so as not to contaminate the sterile interior and not to allow drops of medicine to be deposited on the necks of the ampules (during sealing, the drops would char and cause an ampule to be rejected). To fill 12 ampules with precise amount of solution, roller assembly, in lower part of photograph, squeezes 12 sections of rubber tubing against a flat surface and then moves upward for a set stroke. Length of stroke determines volume of solution introduced through each filling needle.

10

At sealing section of processing unit, filled ampules are transferred from the notched conveyor belt, right, to a notched wheel which carries them through a sealing flame that heats the neck. As the necks are heated, the pulley belt arrangement, foreground, simultaneously rotates each ampule and exerts a downward pulling force. As the glass becomes soft, the body of an ampule is pulled away from its funnel and sealed. Short platform at output side, left, of machine holds ampules long enough for freshly sealed tips to cool. Funnels are automatically ejected by circular wheel.

X-RAY GAGE PROVIDES CONTINUOUS CHEMICAL ANALYSES

CONTINUOUS, on-line analyses of selected chemical elements in materials moving on conveyors or in pipe lines is possible with techniques and equipment developed by the X-Ray Dept. of General Electric Co. With the equipment, solids, liquids, slurries, pastes, and dry or moist powders may be examined, on a production basis, for the presence and amount of up to six elements that have atomic numbers greater than 12. Solids may be in the form of sheets, wires, or rods.

Applications for the equipment, designated an x-ray emission gage (XEG), include monitoring and automatic control functions in industries such as mining, cement, petroleum, pharmaceutical, chemical, and steel. In copper mining, for example, tailings may be checked for copper content and alarms sounded if excessive salvable material appears in the residue. In cement manufacture, aggregate entering the kilns can be analyzed and the results used to control the flow of materials in earlier production steps. Catalyst poisons such as nickel and vanadium can be detected in oils, and the burden charges for blast furnaces can be analyzed prior to use.

In a typical pipe line application, *Fig.* 1, a process fluid is analyzed by subjecting it to x-rays generated in a gaging head above the pipe. The x-rays pass through a "window" in the pipe and excite radiations in the materials. Some of these radiations enter the gaging head where they are passed through collimators and impinge upon crystals set at critical angles.

For each element, there is an optimum geometric angle for a crystal. Thus, elements may be selected for analysis on the basis of the angles at which the crystals are set with respect to the incoming radiations. In the installation shown, the gage head contains six crystals. These may be used to detect the presence of six different elements or, when greater accuracy and stability are required, one of the crystals may be used as a reference.

As shown in the block diagram of a system for measuring one element with a reference, *Fig.* 2, the radiation reflected from each crystal is sensed by a counter tube that measures radiation intensity. Output of each counter tube is fed to an individual preamplifier in the gage head.

In a control cabinet, the two preamplified signals from the gage head—representing the characteristic radiation coming from the element and the reference radiation—are further amplified and fed to individual ratemeters. The ratemeter outputs are then combined in a ratio detector whose output is proportional to the percentage of the element being measured.

Signals from the control cabinet may be used to actuate a digital readout device, recorder, computer, or external control devices. These signals may be interpreted in terms of pounds per ton, tons per hour, or other desired units.

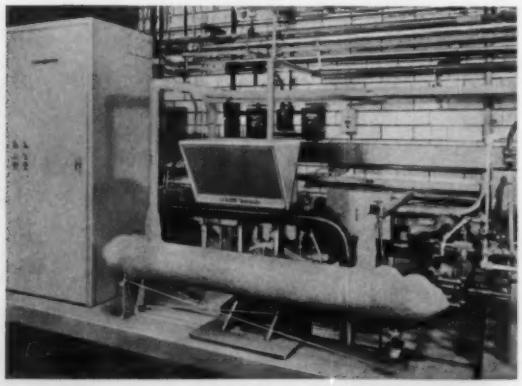
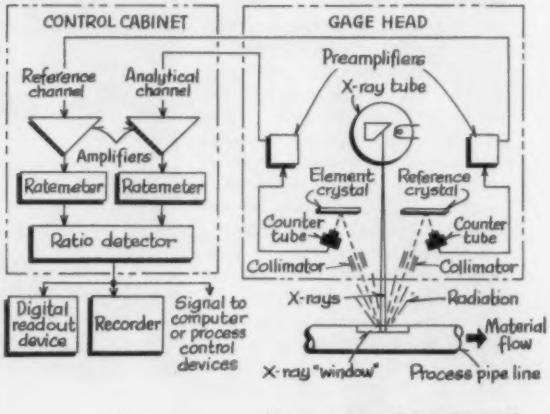


Fig. 1—X-ray emission gaging system for a pipe line installation includes control cabinet, left, and gaging head in triangular housing, center. X-rays generated by a tube in the housing are beamed into fluid in black pipe, and produce radiations characteristic of the fluid's chemical composition. Some of the radiations emitted from the material enter the gaging head where they are analyzed to determine percentages of selected elements in the fluid.

Fig. 2—Block diagram illustrates major components of an x-ray emission gage for measuring the percentage of one element in material flowing in a pipe line. Use of a reference channel improves accuracy and stability by compensating for variations in consistency and output of the x-ray tube.



ENGINEERING COSTS—WHO PAYS?

Part 1

One of the basic problems facing manufacturing engineers is the minimizing of production costs through the use of improved processing techniques. This puts the user of automated equipment, more often than not, in the market for special machinery embodying new concepts. Suppliers of such equipment must expend engineering effort for proposal, design, and debugging. How these costs are to be handled, priced, and billed is a matter of concern for both buyers and sellers. Four buyers from different industries present their thoughts on this subject. Four sellers' viewpoints will appear in a subsequent issue.

BUYERS' POINT OF VIEW

By K. C. BUTTERFIELD
Staff Master Mechanic
Corporate Production Engineering Dept.
Chrysler Corp.
Detroit, Mich.

TODAY'S seminar is entitled, "Engineering Costs—Who Pays?" and indicates that there are several different individuals or groups involved. This, of course, is true. But the principals—in each case—are the user or buyer and the seller or manufacturer. And there is no doubt as to who eventually pays for engineering costs—the equipment buyer does! With our topic question answered so easily you may now ask: "Why the Seminar?" I think the real questions here are: 1. When and how does the equipment buyer pay? 2. How to keep the bill as low as possible?

It's a fair understatement to say that there are problems in these areas, but it is our hope that the following discussion will promote a better under-

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

standing of both the buyers' and the sellers' sides of the picture. Our interpretation of these problems is offered in the light of our experience as typical of a large-scale user of all kinds of machinery and equipment.

The matter of holding down manufacturing engineering cost is very important to the company I represent and to the automotive industry as a whole. This industry is a very large user of capital goods. Investments recently have approached $10 billion and still grow yearly by huge amounts.

The problems of the automotive industry with regard to purchasing automated equipment are not unlike those of any other user. There may be a difference in the user's size. But the problems, which result in the end to a dollar-and-cents consideration, are real, they are not imagined, and they directly affect the net earnings of the builder as well as the cost to the user. But in every instance these problems are those of one business man dealing with another, and to get along at all, the spirit of fair play and honesty must be in evidence. The golden rule still has an important place in business.

Secondly, perhaps the next element that affects the amount of engineering, and by whom, is the necessity to get the job done in minimum time. Too often we find people operating like the characters in the cartoon some of you may have seen. The caption reads—"Of course I want it today—if I wanted it tomorrow, I'd give it to you tomorrow!" "Lead time" is a common term in the automotive industry and the lack of it brings on half-done jobs, rush construction at premium costs, and unhappy relations between buyer and seller in the end.

Integrated Buying Team

In any sizeable purchase of capital equipment, there are, necessarily, a number of people concerned with the negotiations leading up to the placing of the order. In the automotive industry we might call them an integrated buying team—each person with a responsible function to perform. When this group functions exactly as it should, the problems of costly pre-engineering and other excessive costs are materially reduced. Although there are others involved, the main members of this team are: 1. The Process Engineer. 2. The Purchasing Agent. 3. The Manager (Plant & Divisional).

The *process engineer* is number one man on the firing line. It is his thinking, of course, that initially brings forth the need of a certain machine. If his processing has been done carefully there will be a minimum of the so-called "process changes" later. He, probably more than anyone else, directly affects the over-all cost of the project. And in obtaining information for his processing, he is the one influencing the amount of pre-engineering done by vendors. How this occurs is covered in succeeding paragraphs.

The *purchasing agent* is the eyes, ears, and communication center for the process engineer. The purchasing agent must at all times be abreast with the current state of progress of all programs and projects, and aware of conditions at vendor plants. He cannot perform this function if he is short circuited—either by management, process engineer, or some member of the selling team. To aid the purchasing agent in fulfilling his responsibilities, my company requires all vendor contacts be initiated through the purchasing office.

Plant and *divisional managements* also play a big part in any large equipment purchase. Management thinking as to forward planning, past manufacturing experiences, and production requirements is invaluable to the process engineer. We also look to these management people as a bulwark against late product changes which can sky-rocket engineering costs.

Integrated Selling Team

Next, let's cover the selling team—which, too, can be said to be integrated—i.e., each man depending on others for the success of his efforts. This team is composed of: 1. The Sales Engineer. 2. The Engineer. 3. The Company Officer.

In today's marketing of custom and even standard machines and equipment, we on the user side expect a lot from the *sales engineer*. He must know his product and how it can be used. Often times, however, he may require added advice from a more specialized engineer from the seller's factory. The factory engineer is then called in. The calling in of a second engineer adds to the engineering costs, whether the seller charges directly for this service or not. It should be pointed out that the user desires most definitely the services of this extra engineer if the local sales engineer is not sufficiently strong technically for the job at hand.

The *engineer* on the selling team is that ultra-specialist from the factory who many times has the real answers on our problems. After they have been thoroughly oriented on the requirements of the project concerned, many impressive design breakthroughs have been credited to these individuals. The engineers of the companies the user deals with can affect design costs greatly in pre-engineering stages. This is discussed in the paragraph under pre-engineering costs.

The final man on the selling team is their *company officer*. We look to this individual for quick decisions as to what his company can or cannot do in a given situation, and he usually is the individual committing his company for delivery schedules. If the user ever has a quarrel with this individual it is usually because the company officer is overoptimistic—and the dates sometimes go by with expected equipment still undelivered. This creates a hardship in our business because of the fine-timing schedules.

The two teams just described are the ones responsible for all the problems surrounding the costs of a project—and this includes the cost incurred by

the unsuccessful sellers as well as the seller who is favored with the order.

User's Idea of Pre-Engineering Costs

Simply stated, pre-engineering costs are those incurred prior to the award of a contract. Pre-engineering is necessary for a number of reasons, some of which are: 1. For the seller to best plan his proposal. 2. To acquaint the buyer with the seller's ideas. 3. To have sufficient design planning to permit developing a reliable quotation. 4. To develop work load phased into delivery requirements.

In recent years we have noted what seems to be a growing belief on the part of some sellers that the buyer should assume these costs. The user invariably disagrees with such thinking. At the start of this paper it was stated, the customer eventually pays for all engineering costs. This includes pre-engineering costs.

The customer pays for this type of engineering done by the successful bidder and the unsuccessful bidders as well—because these costs are spread in one form or another over operating costs. These costs are thereby reflected in the pricing of future jobs. For the sellers not to charge the customer in some such manner would mean a loss in their earnings.

Either way, then, pre-engineering is extra monies spent, and our contention is that these costs should and must be kept to a minimum. This involves a high degree of co-operation between the buyer and seller teams, together with the exercising of good judgment and fair play mentioned previously.

To minimize the pre-engineering cost, the following should be noted:

1. A common fault with process engineers is that they do not build up a sufficiently strong set of specifications to delineate clearly what is wanted. Time and again it has been proved that the better the specifications, the easier it is for the seller to quote—and with less pre-engineering.

2. To avoid technical changes on quotations, the process engineer in his specifications must be very sure of the product and capacity information used. For example, a last minute change in volume figures will undo a major amount of engineering in quotes that are ready for presentation.

3. On the seller's part, the pre-engineering drawings should be of assembly outline only, with very little detail drawing. Bear in mind the user wants to know how it works, what it generally looks like, its size, and if it will perform as desired.

4. The more standard an item is, the less pre-engineering is needed for the quote. That which is very nearly a stock item with the seller should take little explanation or pre-engineering. Full advantage should be taken of data on previously furnished items which nearly correspond with what is to be furnished.

5. It is acknowledged, the more custom a job is, the more engineering and drawing will be necessary for any seller who wants to quote. However, in our present day there are not too many new engineering principles showing up on each new equipment quote. If the seller is quoting on a type of equipment he normally produces in his shop, it is a matter of bringing together those items, heads, index tables, hydraulic units, etc., that have been standard and familiar to him. Further, if engineering time is spent on a job he does not receive, the time has not been entirely wasted—it will prove of value as a reference and cut down time needed on future quotations.

6. The minimization of pre-engineering might be spelled out in terms of time. Usually two or three days is ample to prepare an offering as described in preceding paragraphs. In terms of past experience, this may seem a very short time to some sellers, but it can be done.

Rebuilding of Used Machinery

Rebuilding of idle available equipment is one practice the user has firmly grasped to save costs and time. In the auto industry frequent model change brings about early equipment obsolescence. In the past, equipment was so special that this meant complete replacement—a thing the industry cannot now afford and cannot tolerate. Chrysler has participated along with many other users, and practically the entire group of manufacturers of automatic transfer line equipment, in developing industry standards for components. This has been done in a manner which does not limit individual maker inventiveness.

Users of transfer equipment are convinced that much engineering time will be saved through the recombination of these components by what is known as, "the building block principle." Further, much additional time will be saved in construction of the new combinations. Benefits of this program are starting now and will grow.

Rebuilding of present surplus equipment has also been found practical as well. For instance, the author's company, in a manufacturing re-alignment, has made inoperative within the last four years, several engine plants. Much of this equipment is usable by rework for other engines or other uses. Certainly we will endeavor to make the best use possible of it. In this case the more complete engineering information we can furnish on the existing machine the easier the builder can rebuild and retool. We have our own ideas on what the cost of rebuilding each of these machines is and our purchasing department is giving careful consideration to the quotations received for same. In some cases we have decided our own people can rebuild the machines, and they have done so at less than the quoted prices of vendors and in a shorter span of time. This means that while we do not especially want to do machine rebuilding, we will do it if necessary to make the best possible used of our available facilities. And undoubtedly, every user of equipment has in mind this same principle.

Engineering Costs

Automation: After pre-engineering and receipt of an order, engineering takes over in detail. Generally—but there are some exceptions—the practice of the auto industry is to let orders for automation equipment on a design and build basis. Award of the order then is based on that combination, represented by one figure for both design and build. And we believe this to be fair and to result

in a best over-all solution. In this case the builder is wholly responsible for ultimate performance and if a design error causes a malfunction, he looks to his own designers for correction. The one area of concern to builders under this type of contract is that some user comptroller departments require a breakdown of design cost, build cost, tryout, etc. At Chrysler we request and receive this information at the time of quoting.

Special Tools: Contrasting to automated equipment, the handling of engineering costs for special tools in the auto industry is entirely different. Almost all special tools—such as dies, jigs and fixtures—are designed either in the user's plant or on a design contract and the completed design given to a building source.

Design contracts for special tools are usually let on the basis of one quoted figure for a family of tooling necessary to produce a given part. Design shops asked to quote are furnished a part print, routing sheet, flow chart, and reference sections of desired construction. From this they bid one figure for the entire amount of tooling design required for that part.

Engineering Changes: There are two distinct and well identifiable types of engineering changes which entail design considerations, whether they affect machinery, special tools, or automated equipment. These are product changes and process changes.

1. *Product Change*—Whatever is affected must usually be corrected at once or with but little latitude. A minimum of time is allowed for estimating the change, and a negotiated fair and equitable cost is determined.

2. *Process Change*—This change is usually initiated by the process engineer. It's requirement can sometimes depend on whether it can be financially justified. Therefore, estimating for this type of change is required before it is made—either in design or construction.

That Word—"Ethics"

In the workaday world in purchasing equipment there are many contacts between the opposing teams discussed here—the Buying Team and the Selling Team. Over a period of time, certain unwritten conditions have become a standard which we call "ethics." And other practices have become standards by which we govern our business. Since both these areas affect the buyer-seller relationship, they should be discussed before concluding this paper. Here are a few considerations:

1. *How many vendors should quote?*
Answer: Depends on circumstances and what the job is. *Three* are considered a minimum at Chrysler. More often four, five, or six are involved. In a given specialist field there may be more vendors available, but experience and make of equipment now in use determine those to be called in.

2. *What about new sources?*
Answer: The auto industry I am sure is always receptive to and looking for new sources. This does not mean a new source will quote on every job but certainly will be given a chance to prove itself in areas where apparently best qualified.

3. *Who owns the design?*
Answer: Like others, if we pay for the design, we want to have it, and where possible the design is to be drawn on company paper.

4. *Are service books and drawings required?*
Answer: Where we did not pay for design but have purchased a standard item such as a stamping press, we feel a service manual complete with necessary drawings and cross-section is mandatory. The drawings need not be dimensioned, but they should show relative arrangement and part numbers. On extremely critical members where availability of a repair part might be questioned—we reserve the right to have a detailed drawing of that part which we may use in any way necessary to have the part made.

5. *Do detail specifications stifle invention?*
Answer: By equipping ourselves with good specifications we feel the builder is helped to keep his pre-engineering to a minimum. Certainly specs influence the first quote but alternate quotes may be submitted and are encouraged. By these alternate quotes the vendor can present other thoughts on the subject.

6. *Delivery promises—how important?*
Answer: Delivery promises are all important to both the builder and the buyer. Friendly relations, together with necessity, make this an important consideration. Everything else being equal, many vendor selections are made based on past conformance to delivery promises.

7. *What about trade names?*
Answer: An effort is made to keep trade names out of specifications. If necessary, a given name or names are indicated with "and or equivalent." On such things as lubrication systems it should be understandable that one type normally will be used at a given plant.

Conclusion

Although the comments in this paper are drawn from experience in the automotive industry, they also apply in most other industries. It is well to repeat again—that most sound business transactions are carried out best where there is evident good will, honesty, and fair play.

We have shown that the purchaser does pay for engineering costs—but what he pays and when—is influenced greatly by the decisions of people on both the buying and selling side. And that the most logical action is to take every measure possible to keep engineering costs to a minimum.

By W. W. KUYPER
Manager, Manufacturing Engineering
Large Steam Turbine-Generator Dept.
General Electric Co.
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WHO pays for engineering costs? The customer pays. But how does he pay? When does he pay? And who owns the engineering? The customer sometimes pays for the engineering as a part of the price of the article he buys. Sometimes he pays for it as a separate item in the bill; sometimes he buys engineering only. Occasionally, he manages to underpay or not to pay at all. But the principle stands: The customer pays.

Consumer

The ways in which he pays are as varied and flexible as industry and commerce. The ordinary consumer, as a customer, is probably at one end of the scale; government procurement of defense products at the other. The industrial situation lies somewhere in between.

When Mrs. Jones buys a refrigerator, she buys the engineering as part of her purchase price—the engineering for design, for tools, and for transportation. Her husband pays for the engineering of his automobile as part of the purchase price. When the Joneses buy a house, they usually pay for the architect's fee, the civil engineer's fee, and all other engineering fees as part of the purchase price. But for larger houses, they often hire an architect, and from him they buy the engineering for the structure and engineering for many of the services within the structure.

When the prospective home builder buys an architect's services, he buys the designs. The customer owns the designs; but it is possible, of course, for the customer to buy designs which are not unique in themselves, and in which the sum of his ownership is really only the paper on which the designs are drawn.

Government

Government procurement of defense products is not so simple. When the government buys a jet fighter plane which is in production, it usually buys certain production engineering as an integral part of the delivered airplane.

But this was not the case during the developmental period of this airplane. Formerly, the Air Force, during the early phases, ran a design competition for which it paid each competitor for his designs. Then the government entered into a contract with two builders for prototypes. In these contracts, certain engineering costs and reimbursements probably were called out as well as profit limiting, renegotiation, and a number of other devices for safeguarding both parties.

For many years now, government and industrial experts have been striving to find suitable bases for reimbursement for such engineering effort and to determine who owns what, and what the degree of ownership is after the designs are made. But this is the extreme problem. For most of us, the problems of paying for engineering costs are simpler.

Industrial

Let us take a more typical situation, where a financier, an inventor, and a mechanic have asso-

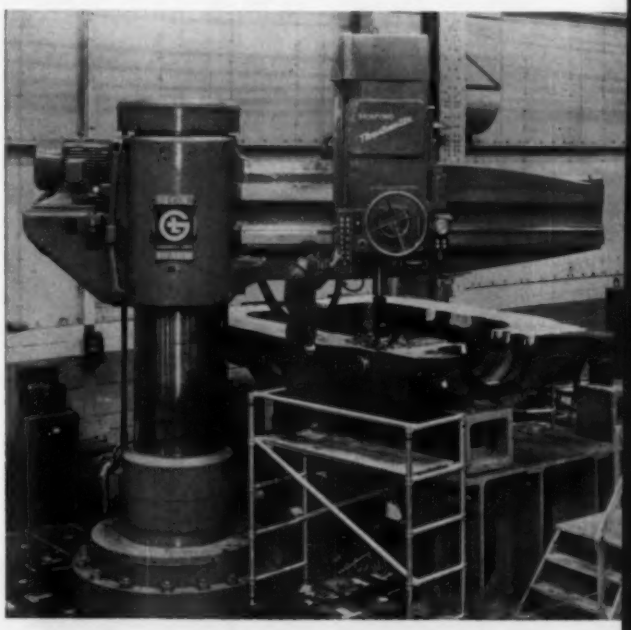

Fig. 1—Pendant controlled 34-inch diameter column radial drill with 10-foot arm was built by Cincinnati-Bickford Div., Giddings & Lewis Co. Drilling head has 50-hp drive motor, and is shown here drilling 6-inch diameter holes in high pressure shell joint at General Electric's Large Steam Turbine-Generator Dept.

ciated together to manufacture and market a new type of household mixer which prototypes and market studies have shown to have an unusually promising future. In addition to money, this group needs designs and manufacturing space.

It is possible for them to have production designs of the new device made by an engineering and design organization. When the group does so, as the customer it owns the design. They can then get simple tools and most prototypes made by an appropriate manufacturer. There is no question here of who pays or who owns.

Machine Tools

The machine tool business shows some interesting facets to this problem. When a man buys a standard Number Five milling machine, he buys the engineering of the machine. If he buys fixtures for the machine, he pays for the engineering in the price of the fixtures. He does not own the design of the machine and he usually does not own the design of the fixtures. But both parties, the vender and the purchaser, usually feel free to use the fixture designs as they see fit.

When a man buys a special machine of standard type, the situation is much the same. To protect their proprietary rights as far as practicable, the builders of special tools spend a great deal of engineering effort in preparing free, detailed proposals for their prospective customers without direct remuneration. They must choose carefully which of their individual possible proposals are most likely to suit them and the customer best. Unless they are adroit, they may do too little and alienate customers, or do too much and increase their proposal engineering costs beyond good business limits.

There is an obverse side to this coin. The customer who asks for too many proposals without buying, or who treats the proprietary designs of the vender too cavalierly may find his venders less eager to serve him when he needs them.

When special machines of a new type are purchased, the problems are similar, but a little harder to solve. A special machine of standard type might be a pendant controlled radial drill of the larger than standard size as shown in *Fig.* 1. The unusual special machine might be a tape-controlled milling machine like that of *Fig.* 2 for milling steam turbine buckets. The line of demarcation is hazy, but in general, the only time the question of direct payment of engineering costs is raised is where the proposed machine is a new special type. And then the question arises more often as a matter of assuring good faith and serious intentions on the part of the customer than for any other reason.

The problems of who pays and when get really sticky only in special circumstances: A customer needs a piece of equipment where straightforward design and construction alone are not adequate for completion of the job; debugging is likely to be excessive; pre-trial of basic ideas is necessary; there are no other probable customers; the hazards in the way of success are considerable; or the customer desires to keep a close control over the development he pays for.

Examples of such equipments might be an automatic assembly machine for a part of unique design, a material sorting and handling equipment between an unusual combination of machines, or an automatic winding machine for automobile starters.

In many of these cases, the customer—the manufacturer of the part—tries to design and develop his own tools. Then he is more likely to own the results—at the price of paying for all necessary engineering and false starts. More likely only, because of the possible incidence of adverse patents or the disclosure of his own knowledge to others.

If the customer is willing to undertake more risk of informing his competitors of what he is doing and of his results, he can proceed like the promoters of the new product: Buy the design, buy the manufacture, and then—in this case—buy the debugging and redesign so common in these special efforts.

So the customer pays, and he holds the controlling reins. He is limited in the speed he can travel by the limits of the industry from which he seeks help and by his own astuteness as a customer. He has the full resources of industry at his command; we are all customer-oriented. He needs only to present a challenge in such a way that a vender can respond with advantage to both parties.

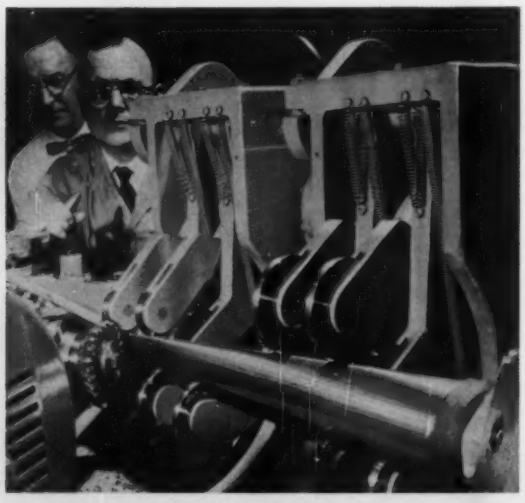

Fig. 2—Workstation view of Ex-Cell-O tape-controlled milling machine shows contour milling operation on steam turbine buckets at General Electric plant.

By R. L. SCHOENBERGER
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THIS subject has been good discussion material for years. However, much of the subject material has been rather general and not specific enough to relate directly to any particular industrial situation. This brief discussion is intended to reduce the problem to within the limits of a particular class of industry with the intent of achieving a more intimate view of a few of the disputed points. The following discussion reviews a few aspects which have some bearing on the problem. This is followed by the consideration of a particular class of industry, mainly as a convenience to the writer in presenting background to the reader so that a better understanding of the comments may be realized.

Type of Industrial Situation

Opinions on subjects like "What Courses Should Be Taught to Engineering Students," "How Can Automation Be Achieved," and so on, including the subject presented here, are all generally related quite closely to the education, experience, and type of industry within the experiences of the person rendering the opinion. Therefore, the following questions and comments would probably lead to a host of differing opinions.

Organization Domination: Is the manufacturing organization large, medium, or small? Is the organization dominated by engineering, or is it dominated by sales, manufacturing, or others? Is engineering a strong staff service, or in a rather insignificant position in the organization?

Nature of Product: Does the company have full control over their production? That is, are the products, services, or items produced in quantities and on schedules dictated by the customers of the company? Or, does the company determine its own product, scheduling, etc.? Is the product itself engineered, or partially so? Or, is the engineering totally involved with manufacturing equipment including special machines, modified standard machines, automatic transfers, or other equipment associated with the manufacture and assembly of the product? Is the product a perishable item, a chemical, a mechanical device, an electrical device, a delicate item requiring special handling, or some other type?

Availability of Standard Equipment: Even if a company may be one of the largest of its kind, it could well be that its total business could be less than 5 per cent of the nation's total. In this case, most of the standard machine builders would probably aim for the very high percentage of the smaller firms. If this should be the case, considerable special engineering may be necessary for a large company if it were desired to achieve higher productive speeds and a higher degree of automation.

Availability of Engineering: Does the company have a reasonable engineering group with several project engineers working in the area of machine engineering? Is the design group assisted by outside engineering services? Or, is this type of engineering done completely by outside groups? If the available machine shops or machine building firms have engineering services, does the company have sufficient engineering help to write specifications and make decisions that will insure the equipment being at least reasonably suited for its purpose at a price that can be justified on an economic basis?

Specific Industrial Situation

Consider the Noname Manufacturing Co. This firm employs 3000 people is a midwestern city of 25,000 people. The product is such that it is not within the area of the machine engineers' function. However, it is a product that is complex and requires a considerable number of process steps and assembly operations. Further, the product is made in a great variety of sizes, shapes, and operational steps. About 60 per cent of the product line lends itself to automatic sequence processing and assembly operations. The nature of the product is such that standard machines are commercially available for only about 60 per cent of the operations, and that automatic transfers for sequence operation are largely in the area of special equipment.

Consider that 100 people are employed in contributing to the technical effort, including research, technical service, plant engineering, industrial engineering, and machine engineering. Further, consider that 10 project engineers are engaged in machine design or automation activities under the direction of a competent supervisor.

The design group has a list of about 500 desirable projects for the current year with perhaps 30 of them involving expenditures of $10,000 or considerably more. The budget limitations and priority are such that 20 major projects have been approved and money budgeted for them. If each engineer is

given 2 major projects for the year, along with several minor projects, it is clear that outside engineering services will have to be obtained to complete the priority list. In this general class of industry, engineering departments grow gradually and a sudden large increase in manning is, in most cases, not tolerated by management. The ten design engineers will not likely be able to complete their assigned lists because of the unexpected involvements in emergencies, follow-ups and revisions on completed projects, and the usual involvement in committees, priority changes, etc. It is, therefore, highly desirable to employ outside engineering services to supplement the company's project engineering group.

Engineering Costs

Consider that the Noname Machine Engineering Department has a machine project assigned which will probably have a value of $25,000, the rough price based on experience and general knowledge of equipment peculiar to the business. The Noname Co., typical of its class, will usually emphasize projects that will permit the company to obtain better utilization of present systems or equipment, or those projects that will pay off in a very few years by combinations of lower cost, higher output, more versatility, less maintenance, etc. Further, lead time and experimental follow-up are so limited that it would appear that the "normal" activity could be classified as a series of "crash" programs.

Continuing with the above $25,000 project, the engineering department is directed to turn the machine over to the manufacturing department for production operation in exactly 8 months. The following schedule is set up for control of the project.

Project Schedule

1. Design, Drawings, Specifications, etc.	1½ months
2. Quotations	½ month
3. Appropriation Approvals and Purchase Orders	½ month
4. Construction	3 months
5. Installation and Revisions	1 month
6. Experimental Production & Follow-Up	1½ months
7. Production Operation	

One project engineer will be assigned full time to this project. He will convert layouts to assemblies, take all other possible drafting short cuts, and utilize some detailing help. Consider the "design package" time of 1½ months at the engineer's rate of about $4.00 per hour with an overhead factor of 2.75. This indicates that, based on six weeks and a 40 hour week, 240 hours or a wage cost of $960 would be in order. Using the overhead factor of 2.75, the design cost would be about $2640. Note that this does not include installation, production follow-up, or any experimental changes which will be done by the company project engineer and the company maintenance shop personnel.

The $2640 should be the quote for the design engineering costs on this project. Certainly, if most of the projects are in the $25,000 to $50,000 class, the cost is reasonable. On $10,000 to $20,000 projects, this cost is a higher percentage (assuming the same number of hours are involved) but, in the writer's opinion, not to be considered unreasonable if the project is complex from an engineering standpoint.

Comments and Recommendations

After a certain amount of experience with this type of activity, the picture becomes clearer as to the amount of engineering to be done by company engineers and the amount of engineering to be done outside. The writer is convinced that there is no substitute for a strong engineering service within the plant. However, this service can often be supplemented to advantage by using outside firms and consulting services. It should be emphasized again that the machine engineering staff in any progressive firm will probably find the list of desirable projects far in excess of available capacity to do them.

A well managed business must always limit the projects to those that can be afforded as measured by the company financial figures, regardless of the advantages to be gained. It is also again emphasized that the majority of these projects are usually limited to either: 1. Those that increase capacity, range, versatility, or output of existing equipment. 2. Those that involve the design of new equipment or achieve lower costs and higher production in the very near future. However, even these "bread and butter" projects usually are presented in a list far greater than the capacity of the usual engineering group.

Certainly, engineering costs must be paid for whether these costs are paid to a staff service group within the manufacturing organization, to an engineering firm, a consultant, a machine shop having an engineering service, or some combination of these. Any firm that does not recognize the need for steady growth in expansion, diversification, and technical innovation is likely to be in a state of steady decay. A company cannot long rest on its laurels and remain in business in the highly competitive spirit of today. Engineering service, whether within the company or from an outside engineering firm, must be paid for and paid for adequately. Failure to recognize this will soon block technological improvements to the extent that the company most certainly will accelerate its own downfall.

In conclusion, it is emphasized that, on any equipment that is considered "special", engineering costs must be reimbursed to the group providing the service. Further, engineering services are true professional services, and the cost of such services might just as well be recognized as an expensive but, nevertheless, absolutely essential expense cost in operating a manufacturing business.

By W. A. STADTLER
Director, Manufacturing Research
International Business Machines Corp.
New York, N. Y.

ONE of the most profitable means of reducing production costs is the intelligent application and use of specially engineered manufacturing equipment. Specially engineered equipment in this discussion is confined to equipment employing new and unique concepts requiring manufacturing engineering development and feasibility studies prior to final design and build.

Few companies maintain manufacturing engineering staffs of sufficient size to permit the development and design of all of their requirements which fall in this category. Even fewer companies have the facilities to build the equipment once it has been developed and designed. It therefore becomes necessary to rely upon outside engineering firms and equipment suppliers to provide these services.

After performance specifications and systems criteria have been determined, the question of procurement procedures becomes pertinent. When specifications and quantities are known, it is standard practice in our company to obtain quotations from a number of venders and then select the most desirable on a firm fixed-price basis. In the case of specially engineered equipment, however, it is extremely difficult, if not impossible, in many applications to estimate with any degree of accuracy the total cost of feasibility study, concept development, design, build, and de-bug. On a fixed-price basis, serious errors detrimental to the purchaser or to the supplier could result.

We have no standard purchasing practice in procuring specially engineered machines. The actual procedure depends upon the type and complexity of the equipment, the state of current technology, the knowledge and specialized experience of potential suppliers, etc.

Where current technology must be advanced to develop the necessary design concepts, we have at times found it advantageous to negotiate a cost-plus-fixed-fee type of contract for the feasibility study, concept development, and prototype design and build phases. The maximum permissible expenditures are specified, and close engineering liaison is established with the supplier. Target dates are defined, costs are reviewed and audited regularly, and development progress is monitored. Cancellation of the contract can be effected usually on prior 30 days written notice. With this arrangement, patent rights and engineering drawings usually are the property of the purchaser. After successful completion of a program, production equipment is purchased on a firm fixed-price basis. We prefer to include in this price the debugging costs in the supplier's shop. Production quantities must be processed for a specified length of time and the equipment must be officially accepted by us before shipment is authorized.

Whenever feasible, we strongly recommend investment in prototype models representing the entire proposed machine, or portions of it, for the following reasons:

1. It provides the basis for comprehensive determination of machine performance specifications, and final equipment design.
2. It permits a far more accurate estimate of final design and construction costs.
3. It reduces many of the uncertainties associated with de-bugging of the final equipment.
4. It makes final delivery dates more realistic and dependable.
5. It provides an interim period which can be used for:
   a. Maintenance experience and training.
   b. Any required part design changes.
   c. Operator training and familiarization.

In the foregoing example, the fact remains that manufacturing engineering or manufacturing research effort is required to produce new breakthroughs in manufacturing equipment and processes which essentially must be custom-built to meet the requirements of one user. Regardless of whether this effort is expended in-plant or subcontracted, the user must pay, and he is entitled to certain rights, including patent protection.

Now let us consider equipment which basically has widespread usage but requires preliminary engineering to adapt it to individual requirements. The basic technology has been developed and suppliers have specialized experience in this field. In our opinion, there should be no charge for the preliminary engineering required for quotation purposes. The only so-called "free" engineering is performed by the unsuccessful bidder. It is not free in the true sense of the word because the costs are included in his engineering overhead and are applied to subsequent equipment sales. The only equitable way in which nominal charges for quotations could be justified would require all suppliers to demand this charge and then pass the savings in engineering overhead along to the user in the form of lower equipment costs. This seems highly improbable.

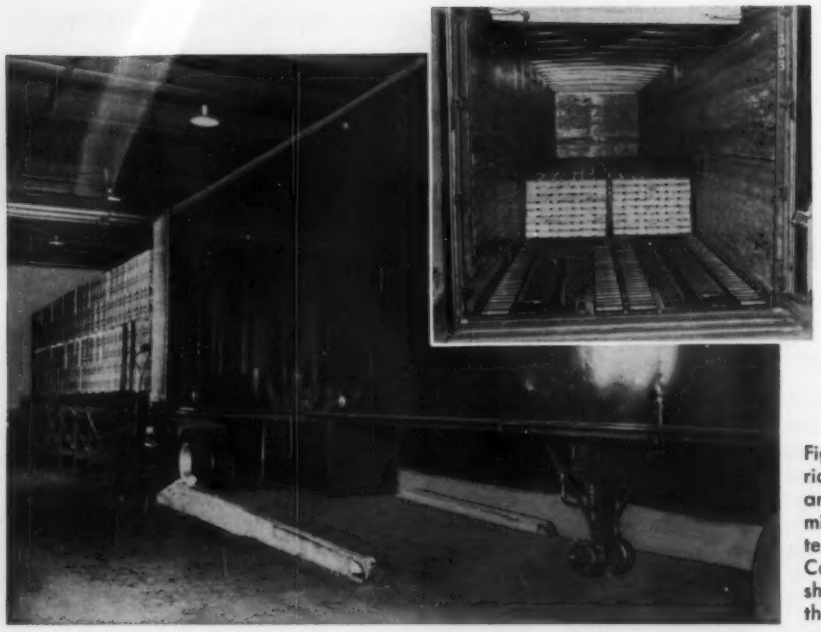


Fig. 1—Pallet loads of materials can be transferred into and out of a trailer in 1½ minutes with a conveyor system developed by Alvey Conveyor Mfg. Co. Inset shows equipment installed in the bed of a trailer.

PNEUMATIC SYSTEM SPEEDS TRAILER LOADING AND UNLOADING

TRACTOR-TRAILER facilities play an indispensable supporting role in the over-all operations of many industries. Typically, they are used to deliver raw materials, subassemblies, and semifinished parts between plants or from suppliers, and to ship finished products to distribution centers or points of use.

When trucking hauls are short, trailer loading and unloading operations can consume a relatively large proportion of the total transit time. In many cases, the economic necessity of closely and carefully packing a maximum amount of material in the confined space of a trailer often results in considerable standby time for loading and unloading crews. If the cargo is perishable, an additional factor—that of health considerations—may require rapid handling in and out of trailers.

The concept of handling unitized pallet loads of materials with fork trucks has done much to improve the efficiency with which goods can be transferred

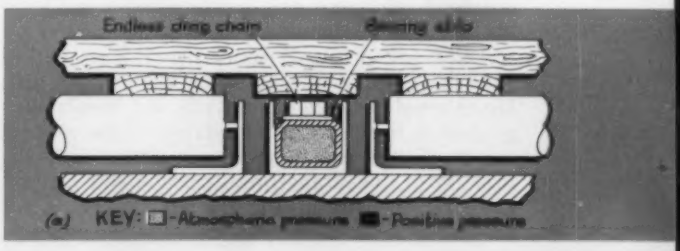


Fig. 2—Major elements of conveyor system include a pair of roller tracks for each pallet row, an endless drag chain that may be driven in either direction, and a flexible hose that can be inflated and deflated by air pressure to raise and lower the drag chain with respect to the bottoms of pallets. A bearing plate beneath the chain protects the hose from damage due to abrasion. Sketches *(a)* and *(b)* illustrate, respectively, the position of the drag chain in its normal and operating condition.

into and out of trailers. However, even this procedure is limited in effectiveness. For example, careless operation of fork trucks can result in damage to cargoes or trailers. Also, special precautions necessary to protect personnel may hamper operations during peak load periods when truck traffic is heavy.

With a view toward improving the efficiency of trailer loading and unloading operations, Alvey Conveyor Mfg. Co. has developed a self-powered, mechanized conveyor system, *Fig.* 1, that can be installed in a trailer. With the patented equipment, a 32-foot trailer can be fully loaded or unloaded in 1½ minutes. Palletized materials that can be handled include paper, baled goods, metal ingots, and cartons of bottles and cans.

System Operation

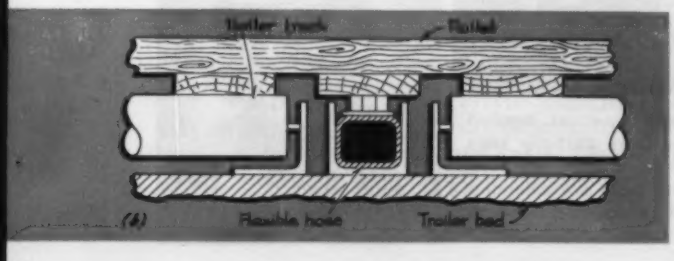
In a typical trailer installation, *Fig.* 2, each row of pallets is supported on a pair of roller tracks extending the length of the trailer. Usually, two pairs of tracks can be placed side by side in the trailer, and pallets may be stacked two high in each row.

Between each pair of roller tracks for a pallet row is an endless drag chain that may be driven in either direction. In its normal position, *Fig.* 2*a*, the top of the chain is below the level of the bottoms of pallets in a row. This section of chain rests on a hardened steel bearing plate which is supported by a length of flexible hose.

To move the pallets in a row either into or out of the trailer, a valve is operated manually. This admits air into the flexible hose from a pressure tank. Resulting inflation of the hose then raises the bearing plate so that the top chain section is lifted into contact with the bottoms of the pallets, *Fig.* 2*b*. With the chain moving in the proper direction, pallets are either loaded or unloaded from the trailer by virtue of the friction between the top of the moving chain and the bottoms of the pallets.

Air pressure in the flexible hose is regulated so that sufficient friction is generated to move the pallets. However, if the pallets meet an obstruction—as when the first pallet in a row reaches the front of the trailer during loading—the chain will slip relative to that pallet. Thus, inherent protection is afforded to the pallets and equipment when the pallets reach their final positions with the chain in motion.

After a loading or unloading operation is completed, the air in the flexible hose is exhausted to atmosphere. This causes deflation of the hose so that the bearing plate and upper chain section lower to the normal position shown in *Fig.* 2*a*. In this condition, the system may also be used for manual operations by pushing pallet loads over the roller tracks.



Auxiliary Equipment

Air for inflating the flexible hose is obtained from a pressure tank which has an integral hand pump. Normally, pressure in the tank is held to about 40 psi. From the tank, the air passes through a pressure regulator that provides a constant pressure of approximately 5 psi for inflating the hose. This pressure may be varied, however, to meet changing operating requirements. Power for driving the chain is obtained from an auxiliary gasoline engine that has a battery operated self-starter. All of this equipment, and the control valves, are mounted in an enclosure attached to the underside of the trailer, *Fig.* 3. Doors on the enclosure permit ready access to the components for maintenance and servicing.

Fig. 3—Equipment mounted in an enclosure attached to the underside of a trailer includes a 2½ horsepower gasoline engine for driving the drag chain, a hand-pumped air tank, a pressure regulator, control valves, and pressure gages.

Other Applications

Although the application described is that of a trailer installation, the system is adaptable to intra-plant operations as well. For example, it can be used as a handling link between a production line and a shipping dock or warehouse. It can also serve as an accumulating line for incoming and outgoing palletized materials. In such applications, the auxiliary equipment needed for trailer operation may be replaced with other components and plant services. For example, electric motor drives may be more convenient in a plant, and shop air lines can be used instead of hand-pumped pressure tanks. An opportunity also exists in a plant for integrating the system with other equipment so as to provide automatic cycling of the conveyor in accordance with process needs.

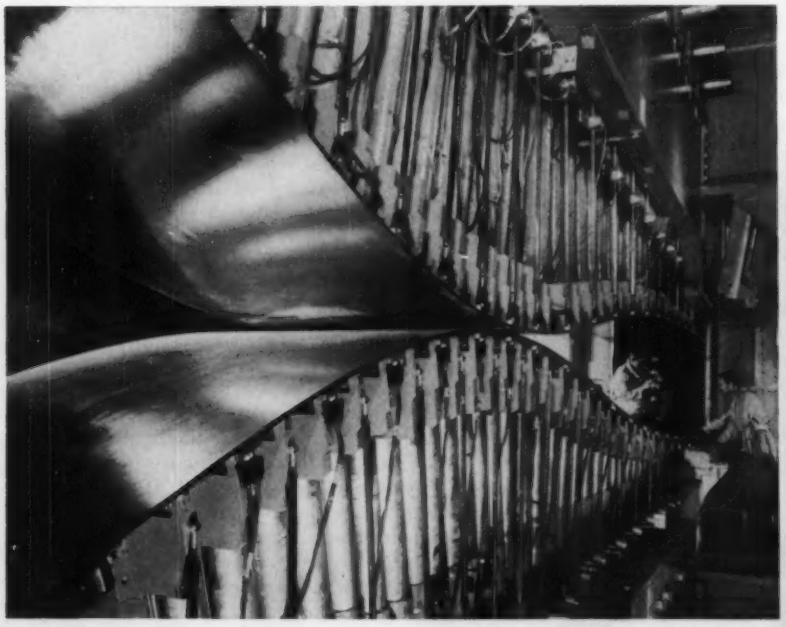
HEAVILY LOADED PLATES POSITIONED ELECTROMECHANICALLY

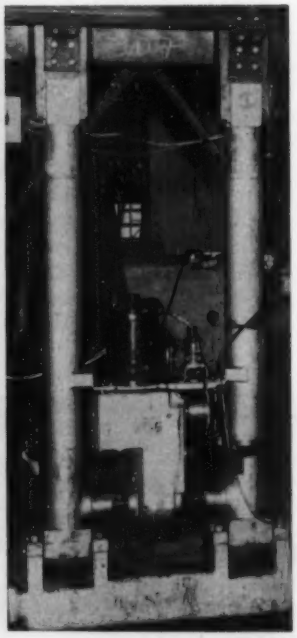
EXPERIMENTAL work is generally thought of in terms of scaled down forces, but the forces exerted by an electromechanical positioning system at Arnold Engineering Development Center, Tullahoma, Tenn., are large enough to be used in nearly any industrial requirement. A wind tunnel facility at the Center was built with movable top and bottom surfaces between flat parallel sides. Stainless steel top and bottom surfaces 40 inches wide and 0.44 inch thick can be deformed along a section of the tunnel to provide varying height of opening. The height may be adjusted from 0.560 to 40 inches.

Positioning of these surfaces is accomplished within 0.002 inch by 80 pairs of ball-screw jacks—40 pairs for the top and 40 pairs for the bottom. Under operating conditions, a pair of jacks may carry a loading as high as 130,000 pounds while accurately maintaining the desired position. The jacks for the top surface are trunnion mounted between a supporting frame and bosses on the one-piece steel plate 28 feet long which forms the top surface. A similar mounting arrangement is used with the single plate which forms the bottom surface.

Each pair of jacks is independently driven by a continuously running electric motor. Through appropriate gearing and the use of two magnetic clutches built by Fawick Corp., each pair of jacks can be extended or retracted to produce the desired hourglass contour along the tunnel.

Adjustments of the jacks are sensed by potentiometers attached to the supporting frames and operated by special bars attached to the plates. The special bars are made of Invar to minimize any thermal effects. Setting of each potentiometer is compared to the setting of an associated master potentiometer on the control panel. The pair of jacks is automatically extended or retracted by selective energization of the clutches to attain and maintain desired jack lengths.





Precise positioning of steel plates to obtain and hold desired contours, against high pressure loading, is performed by 80 pairs of screw jacks partially seen from one side in the over-all photo. Inset shows one pair of jacks as they would appear looking at one end of the bottom plate. Both jacks are extended and retracted by the motor and combined clutch and gearbox mounted between the jacks.

AN APPROACH TO AUTOMATION IN PRODUCING MISSILE COMPONENTS

Frequent product design changes, mixed production quantities, and short lead times are characteristics of missile manufacturing operations. In such a climate, how can the introduction of automatic production equipment be justified? The answer lies in pinpointing those areas where technical manpower savings, quality improvements, and shorter delivery intervals can be effected. Equipment must be versatile to ensure maximum utilization.

By **J. B. CUNNINGHAM**, General Supervisor, Tool Engineering
Convair Div., General Dynamics Corp., Pomona, Calif.

TO INTRODUCE automated equipment into a manufacturing plant requires more than the enthusiasm of one individual. Such a move must have the co-operation of all people who can influence the success of the equipment. Usually, a significant portion of a company's managing staff becomes involved in an automation project. While these people do not necessarily take an active part in putting the automated equipment into operation, the course of their attitude is invariably felt by those who have direct contact with this phase of the project. It is imperative, therefore, that management people accept responsibility for putting such equipment into use. Failure to exercise this responsibility has been the downfall of many new production ideas. With automation, the consequences of neglecting this management function can be even more severe.

With proper teamwork, it is quite practical to introduce automatic production techniques in many missile manufacturing areas. Success in such endeavors is limited only by the imagination and common sense applied by all the people concerned.

Economics And Ingenuity

The application of automation techniques in the guided missile field is more difficult than similar efforts in high production industries such as appliance and automotive. This is because lot sizes are relatively low and the frequency of engineering product changes is usually high in the missile field. As a result, missile manufacturing installations more closely resemble large job-shops than they do high production plants. Although the volume of work

PRODUCING MISSILE COMPONENTS

may be large enough to call for mass production of certain missile components, most of the products do not qualify for this type of production.

Intermixing of low and medium-high volume parts is not the only problem in missile manufacture. There is also the one imposed by continual product changes. Therefore, when considering automation in this field, the incidence of engineering changes must be accepted and provision for these changes built into the equipment itself.

As many an automation user can attest, the application of this production concept is usually fraught with problems. Not the least of these is the initial debugging of the machinery itself. Here, limited part production life is a serious handicap if it takes a long time to put a new piece of automatic production equipment into use.

For example, there are cases where the product drawing for a new part is taken directly from the engineer's drawing board and presented for manufacture. While several thousand parts may be required, the delay caused by preparing the production process sequence and by designing, building, and proving-in an intended piece of automation equipment often exceeds the interval when some of these parts are needed. Therefore, it becomes necessary to also provide tools and fixtures that can be used in the interim. This not only cuts down on the number of parts that are left to process through the automated machine, but also means that additional expense is involved in making the temporary tools.

With these obstacles, it becomes necessary that missile manufacturers decide in favor of a particular piece of automated equipment long before new part drawings are released. By implication, the nature of the machine or device must be such that it can be used on any of several types of parts. Then, when the machine becomes available for use, specific missile parts which fall into the preconceived part-type configuration can be assigned to that machine.

Another area of importance is simplified changeover and setup. Because of schedule needs and the prospect of engineering changes, it is impractical to set up a piece of automated equipment and allow it to run off an entire production quantity. Instead, it is more desirable that the whole quantity required be divided into smaller lot sizes. Then, after

1 NUMERICALLY CONTROLLED WELDER

This machine was procured for the purpose of production welding missile folding control fins and dorsal fins. The control fins are fabricated of 17-7 PH stainless steel. The airfoil material itself is composed of sheets that are sandwiched together in varying thicknesses and welded to a spar-forging. Each control fin requires 472 spot welds. The dorsal fin is less complex, being made of 1020 steel and consisting of fewer components. The welding machine for these parts, developed by Linde Co., Div., Union Carbide Corp., is numerically controlled by tape. It includes an inclinable workholding table with fixtures attached; a cross slide unit maneuverable in two horizontal plane directions; and four torch slides that serve to bring the torch tips in contact with the work after the correct point-to-point position has been achieved. Welding is by the inert gas shielded arc welding process.

Capacity of the machine is four workpieces, each 20 by 20 inches maximum. Larger workpieces may be accommodated if more than one torch is to perform welding at any one time. For example, the dorsal fin application calls for all four torches during any one weld sequence step.

The fixtures supporting the workpiece are separate and detachable from the machine platen so that different weldments can be produced on the machine. Control is achieved automatically by a punch-tape program control unit. Manual overriding of the tape system is provided for experimental and setup operations. Adaptability for the welding of other production parts, in addition to the folding and dorsal fins, has been designed into the machine. The equipment is therefore a multipurpose unit which operates over the entire range of the Heliarc spot weld process and has a dimensional capacity sufficient to accommodate many production parts. In accordance with a predetermined spot-position sequence, the machine welds to any pattern with repeatability within 0.001 inch.

The tilt table affords a means of placing a part in a plane that is inclined up to 20 degrees from horizontal. The two-direction slide mechanisms can then scan and place welds anywhere in the horizontal plane within their 20-inch ranges.

Parts to be welded are preassembled and tack welded before they are loaded into the fixtures. In the case of the folding fin, no restraining clamps are used to hold the parts in position. However, there are restraining devices inserted within the weldments to maintain internal dimensional tolerances and to control distortion. Dorsal fins are restrained in the fixtures by pneumatically operated clamps. Fixture nests locate the parts with respect to a zero position of the *X* and *Y* axes. These nests are designed to permit welding on both sides of the weldment by manually turning the part 180 degrees periodically during the weld sequence cycle. Up to two such operations are currently used.

The four fixtures are located on a flat table which is trunnion mounted. The table is positioned on the *Z* axis, which positions the surface of the workpiece perpendicular to the welding electrode's down travel. This is necessary in order to maintain exposure limits on the electrical arc.

The program control section consists of several major components. A Friden Inc. Flexowriter typewriter is used to prepare program tapes from predetermined location and condition data for each weld. This unit can also be used to make

one of these lots is completed, another lot for an entirely different part must be produced, and so on. Under these conditions, a fast setup capability is mandatory.

Being cognizant of the value of special machines in our operations, we are now engaged in a program aimed toward adoption of the "module" machine design concept inspired by the automotive industry. By classification, the rotary indexing worktable (dial) type machine is best suited for most of our hole-machining operations. The module concept can be applied to these machines with great practicality. Budget factors permitting, we intend to convert to this manufacturing medium within the next two years. Significant savings are expected from the standpoint of capital equipment conversion costs (incurred when product configurations change) and direct labor costs.

If existing equipment can be converted to operate as efficiently as new special machinery, it will certainly be used. If it cannot feasibly be converted, and special machinery does not fit into the budget, the existing equipment might be arranged to permit an operator to run two or more machines. Auxiliary pushbutton control stations are useful in such instances, as are automatic loaders and similar handling devices.

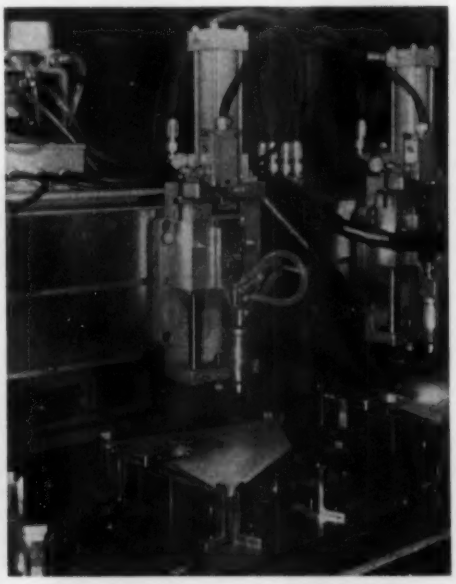
All of these restrictions tax the skills of equipment designers and inherently increase the cost of machines as compared to single-purpose automation units employed by mass-producers. Most of the current applications of automation in our plant are based on the conservation of manpower rather than spectacular production increases.

At this point it should be stated that relatively few missile parts can benefit from automated manufacturing machinery. While the potential for such applications is on the rise, by necessity the scope will be limited until the time when product designs mature to a "no change" status and production quantities are larger.

At Convair Div., General Dynamics Corp., we have approached the use of automation with emphasis on equipment that approaches universal application. The key to our success has been in making use of machine design and industrial engineering principles that provide this characteristic to as great a degree as possible. With this in mind, several pieces of automated equipment have been built or procured, and we are currently enjoying the resulting savings. Some of this equipment will be described in accompanying pages. Application areas include welding, drilling, circuit board manufacture, and automatic testing and analyzing.

additional tapes from a master tape. It can be located remote from the machine proper for more convenient use if desired. Our practice is to prepare tapes in our Tool Engineering Dept. so that this process can be integrated with normal tool design functions.

Use of this machine to mechanize what was a hand-gun operation has created not only a conservation of manpower, but has also allowed achievement of quality levels heretofore unattainable. In addition to its primary function of welding dorsal and control fins, the machine can be used for less complex, conventional weld applications. This ensures its continued utility at full production capacity.



2 TAPE PROGRAMMED TURRET DRILL

A tape controlled Burgmaster drill press manufactured by Burg Tool Mfg. Co. Inc. is a recent acquisition. Equipped with an Electropoint control system built by Electrosystems Inc., it is similar to a standard machine with the addition of a positioning table and the control system.

Frequent product design changes, production quantities of large and small size, and short lead time available for tooling dictated the need for tape controlled drilling equipment. Economies in production time and in tooling cost contribute further toward its value.

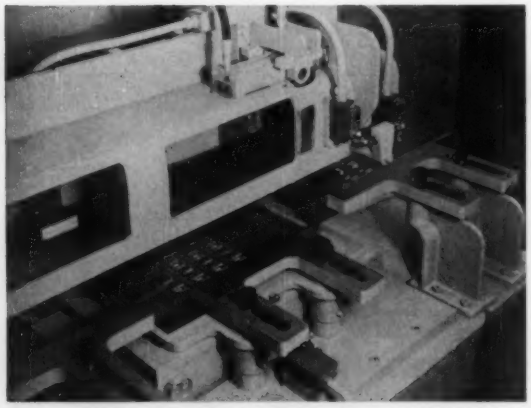
Prior to purchase of the equipment, it was estimated that the savings in tooling costs on only five parts on a previous contract would amortize the capital outlay in one year. Subsequent experience has demonstrated that such tooling cost savings are possible as well as improved production efficiency and rapid accommodation of product design changes.

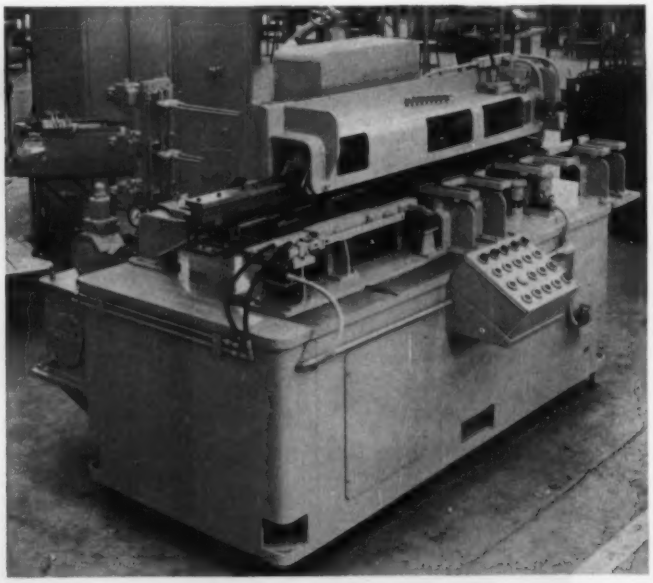
Drill jigs are simple holding fixtures that have target or setup holes for indicating table position. No drill bushings or costly jig-boring work is necessary. Tapes are normally prepared in the Tool Engineering Dept. and require a minimum of conversion from design dimensions. Changes in hole size or position require tape changes only; no fixture rework is involved.

Operator efficiency does not affect the over-all machine cycle except during the loading and unloading phases. It has been our experience that we can expect an increase of up to 50 per cent in standard-hour realization on most drilling operations with this machine.

Accuracy of work produced has been consistently good on close tolerance parts. Rejects—previously associated with poor alignment of drill and bushing, worn bushings, undersize drills, and omitted operations—are now absent. To run a new part, a simple workholding device is made and a new tape prepared using a manually operated punch. With such basic simplicity of changeover, the machine has extremely broad applicability.

3 CIRCUIT BOARD PROCESSING





DIP SOLDERING MACHINE

One of the first steps taken to improve our circuit board production facility was the development of an automatic machine for dip soldering the clinched-over wire leads on etched boards. Substantial labor savings and greater component reliability were in sight if this work could be done on automated equipment.

As part of a manufacturing research and development study, a survey was made to determine whether a machine was already available that would serve our purpose. Following an exhaustive quest, which included numerous trips to other facilities, it was concluded that no such equipment existed. It then was decided to design our own machine based upon expected high production.

Early experiments were devoted largely to an investigation of fluxing, dross elimination, and tooling. Pursuing one design concept, a prototype model was constructed that tested the principles which had evolved in the experiments. A degree of success was experienced that made it logical for us to embark upon the design of a production model encompassing all of the factors learned.

To this end, a six-station in-line transfer machine was engineered that promised to more than meet the immediate production requirements (which were destined to increase as time went on). The machine was to be hydraulically powered and electrically controlled, and attain an average production rate of one complete circuit board every second. Also, it was to be the first machine at our facility with a built-in provision for self-loading and unloading. This last criterion would make it possible to integrate the dip soldering machine with an entire automated circuit board manu-

facturing line if desired at a later date. A magazine loader would provide storage float. If the machine were operated as a single unit, parts could be hopper fed into the magazine, resulting in a savings in manpower.

There are seven basic functional stations in the machine. These include: Load, preheat (3 stations), solder, cool, and unload. Without the magazine loader, circuit board assemblies may be manually snapped onto an adapter pallet. The pallet is then slid into way-grooves at the load station. Several pallets may be loaded in this manner until the 18-inch long station is full.

Depression of a *Cycle Start* button transfers the circuit boards sequentially to each of the three preheat stations where their undersurfaces are warmed for better solderability. There is also provision for fluxing the circuit paths during the preheat phase, although we prefer to do this prior to loading when relatively short runs are involved. Next is the soldering station where the warmed copper circuit paths are lowered to contact the molten solder (see photo insert). There follows a vertical "jogging" action which removes trapped air from beneath the boards. The soldered boards are raised and transferred to the cooling station and then to the unload area.

As each station normally contains several circuit board assemblies, one transfer stroke more than matches the production goal of one unit per second with a machine cycle time of approximately 14 seconds.

An electrical control panel sequences the operations automatically. However, depression of a *Manual* button allows discrete phases of the machine's cycle to be operated separately with individual pushbuttons.

While the machine normally employs a pallet to hold each workpiece during processing, it also has adjustable ways which can be set to run any width of board within the machine's capacity without need for the pallet. We anticipate that no circuit board will be designed that would be too small or too large for this piece of automated equipment to handle.

ETCHING MACHINE

To further modernize our circuit board production facility, an automatic etching machine was procured. This machine is suitable for volume etching of single or double-sided circuit boards, and is adaptable to either a continuous processing line or a single work center. Use of this machine results in production cost savings of $1.98 per missile, which allowed its amortization over a reasonable number of units produced. The etcher is continuous and automatic, and incorporates a water rinse within the machine. It is capable of etching one ounce of copper at the rate of 120 linear feet per hour.

The machine's transfer mechanism is variable, and may be set at any allowable traverse rate. Constructed largely of polyvinyl chloride, all internally exposed metal parts of the machine are made of titanium, thus rendering it highly resistant to the ferric chloride etchant solution. Nonclogging Teflon spray nozzles are used for the solution.

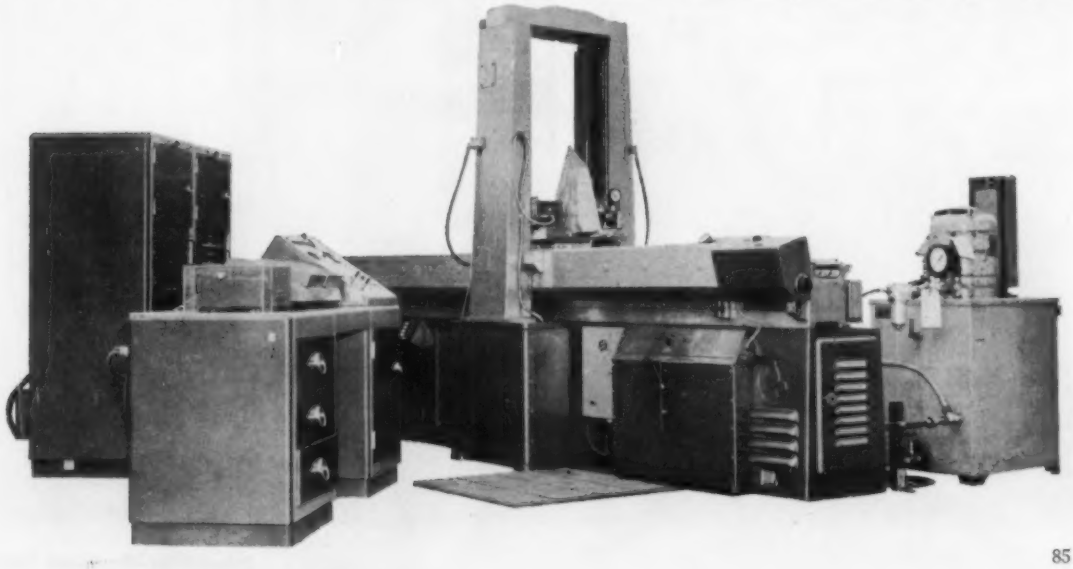
Capacity is such that circuit board panels up to 22 by 25 inches can be handled. The machine has transparent sides to permit viewing of the panels during the etching operation.

With physical and electrical modification, this etcher could be integrated with "before and after" processes to allow completely automatic loading and unloading. It is "universal" within its maximum dimensional capacity, and it is not expected that future product configuration changes will affect the usability of this machine.

4 CONTROL SURFACE ANALYZER

An airfoil control surface analyzer was developed to perform a specific mechanical gaging function on missile and booster fins. Its purpose is to determine the dihedral, incidence, and camber of an airfoil. This information is subsequently resolved to establish an orientation datum point used to relate the control fin's surface configuration to the actuation mechanism within the missile (provided the configuration is within acceptable limits).

The machine automatically measures airfoil asymmetry at



40 preselected points, feeding its data into a computer that determines the local camber and incidence for the area represented by any one point. As it is impossible to fabricate a perfect aerodynamic surface, point-by-point measurement is not adequate in itself. The machine therefore sums and integrates the point-by-point data to compute the over-all camber. Each computation is tabulated by the machine, along with special data indicating the amount of dihedral. At the end of the process, an operator is presented with the values of dihedral, total effective camber, and incidence. A self-check by the machine indicates proper over-all system operation. If a malfunction is detected, a simple monitoring procedure isolates the faults to one of the major sections of the system.

"In the manual process replaced by the analyzer, data taken with an alligator gage was hand-tabulated and later used in the solution of two separate equations which were solved with the aid of a desk calculator. Two men inspected each airfoil to reduce the possibility of introducing human errors. These measurements required as much as 1.4 manhours per part inspected. The analyzer processes the same part in 0.1 hour or less, checks more points, improves data accuracy by a factor of 3, and minimizes human errors.

The analyzer was developed for a specific purpose, but is easily adapted to a variety of precision gaging applications. For example, on cast booster fins, raw castings can be inspected prior to machining, which prevents labor being spent on parts unacceptable from the beginning.

Control of the analyzer is by punched tape, using binary input commands. Measurements are made with optical-type digital transducers, and a hybrid digital-analog-digital computer is used for computing and tabulating process data.

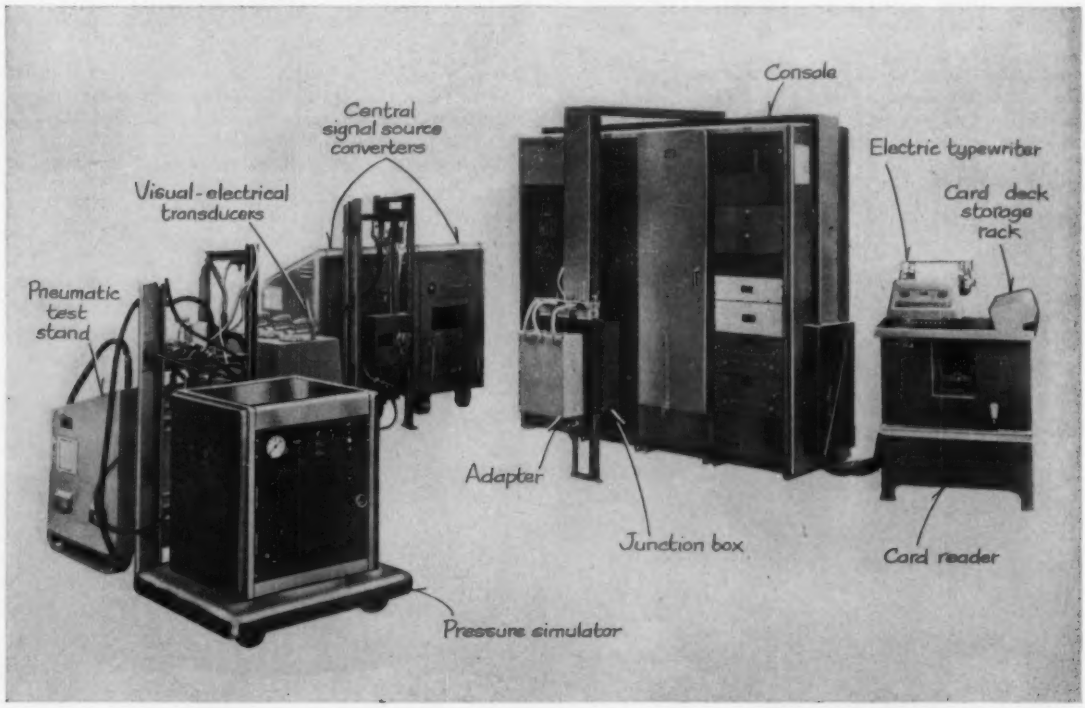
The analyzer represents an attempt at universal application, and significant technical manpower has been saved for use in other complex inspection areas. Furthermore, with the device, the total elapsed time to produce a missile is shortened without need for additional manpower. Thus, through use of automation, critical weapons are made available for combat use much sooner than when conventional manufacturing principles were employed.

5 AUTOMATED TEST EQUIPMENT

All functional units in missiles must be tested thoroughly before they can be accepted as battle-ready weapons. Our early missile programs required rigid tests that were accomplished using test gear demanding a high incidence of manual manipulation. The corresponding operating manpower was high.

With increased missile sophistication and complexity, as well as expanded production requirements, it became advisable to design test equipment that could automatically check out various functional elements in a programmable, predetermined sequence. This equipment has been devised to analyze and diagnose all critical control elements; namely, electronic, pneumatic, hydraulic, and mechanical.

As a result of developing and using automated test equipment, cost factors reveal that this move toward automation has been profitable. In 1953, a production rate of *N* missiles per month required an investment in nine test equipment stations costing $234,000. A total of 80 individual test measurements was made, and an average of 529 manhours was required to set up for the test, calibrate the test station,



run the test, reduce the data, and perform trouble isolation and failure diagnosis as required.

In 1959, a production rate of *N* missiles per month required an investment in two test equipment stations costing $184,000. A total of 250 individual test measurements was made, and an average of 37.3 manhours was required for test setup, calibration, test operation, data reduction, and trouble isolation and failure diagnosis.

The equipment is automatically programmed by punched cards read in sequence by a card reader. Automatic test data printout is accomplished with a modified electric typewriter. The unit is made up of basic "building block" modules which can be combined into various configurations to meet new test problems as they develop. The module concept also simplifies the design process, manufacturing, provisioning, spares support, maintenance, and systems integration.

Basic elements of the automatic test equipment system include:

1. An automatic card reader and auxiliary relay trees for test programming and control.

2. Precision ac and dc test stimuli sources with ranging provided by a punched card controlled digital-to-analog converter.

3. A magnetic core memory for storage of test data.

4. A digital timer for test timing control.

5. A time-to-dc converter for checkout of missile program timer functions (timed functions are converted to dc voltages numerically equal to the time or times involved).

6. A high speed analog-to-digital converter (precision digital voltmeter).

7. A voltmeter input sequencer which provides sub-routing switching (punched card controlled) for analog-to-digital converter control.

8. Noise converters (noise power and noise peak) for system noise content measurement.

9. A typewriter sequencer (punched card controlled) which reads test data stored in the magnetic memory and transfers it to an electric typewriter. The typewriter sequencer also contains a digital comparator for *Go* or *No-Go* determination.

10. An ac to dc converter (punched card range controlled) which converts ac test signals to dc permitting readout by the dc analog-to-digital converter.

11. A card sequence checker to ensure that cards in a deck are in proper sequence.

12. A remotely controlled electric typewriter. The typewriter prints out alpha-numerical information including test identification, quantitative test data, and a *G* or *N* to indicate *Go* or *No-Go* for each test performed where this type of decision can be made by the test equipment system.

13. Appropriate regulated power supplies, ac and dc, to power the test equipment and the missile or missile component under test.

Punched cards are fed into the card reader to control all operations of the test unit. For each test station three groups of cards are required: The first group programs a production test for the component; the second group of cards removes the information stored in the memory core during the production test, checks values against tolerance limits punched in the cards, and causes data to be recorded on the typewriter; the third group is used to perform a periodic (once or twice daily) shop test procedure upon the test unit. The cards of the various groups differ in color to eliminate confusion.

To perform any test, the appropriate group of cards is placed in the input rack of the card reader. The operator then presses a *Start* button, and the test proceeds automatically. The cards appear in the output rack of the card reader (stacked in the same sequence) at completion of the test. Where manual adjustments must be made to the component under test, the setup for the adjustment is made by a card, but the advance to the next card is controlled by the operator.

It is not always possible to assign a tolerance to a particular parameter during a production test. This condition occurs when one parameter is related to another. For example, in the two measurements taken to determine the integration rate of a linear integrator, only the difference between the two values is important. In the future it may be possible to add a small, transistorized digital computer to the memory output to perform required mathematical computation on this type of parameter. At present these parameter values are followed by a letter other than *G* or *N*. The operator then refers to an instruction sheet for the appropriate computation to determine *Go* and *No-Go* criteria.

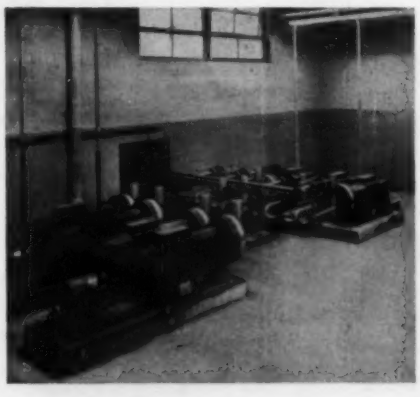
Much importance has been placed on the ability to quickly switch from one set of test parameters to another. The use of punched cards allows value and sequence changes to be made without a general modification of the equipment itself. Also, the use of a module, or building-block, design allows us to make major changes within each module to meet drastic test procedure innovations when required by new missile designs. The accompanying illustration represents a typical grouping of modules for a particular test setup.

leakproof pumps handle corrosive fluids

ISOLATION between a working fluid and process acids is accomplished with a bank of duplex head, positive displacement pumps developed by the Process Equipment Div., Lapp Insulator Co. The pumps are used by an appliance manufacturer to transfer acids from storage tanks into vats used for scaling and conditioning metal.

Each pump includes an adjustable-stroke piston operating in a cylinder. As the piston is reciprocated, oil in the cylinder moves a diaphragm back and forth. During the back stroke of the diaphragm, process fluid is drawn into a reagent head through suction check valves. This fluid is forced through a discharge valve during the forward stroke of the diaphragm. No stuffing boxes, seals, or flush streams are needed, so that leakage of expensive and dangerous acids is not a problem.

In five years of operation, yearly maintenance costs for the pumps have been less than 5 per cent of the initial purchase price. In addition, uniform acid concentration can be maintained in the processing vats so that all of the products receive the proper treatment.



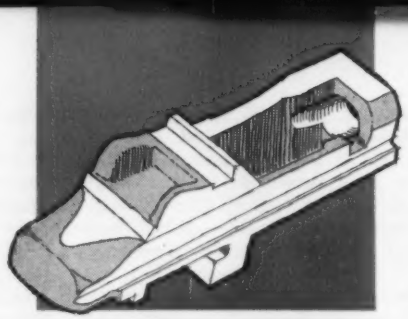


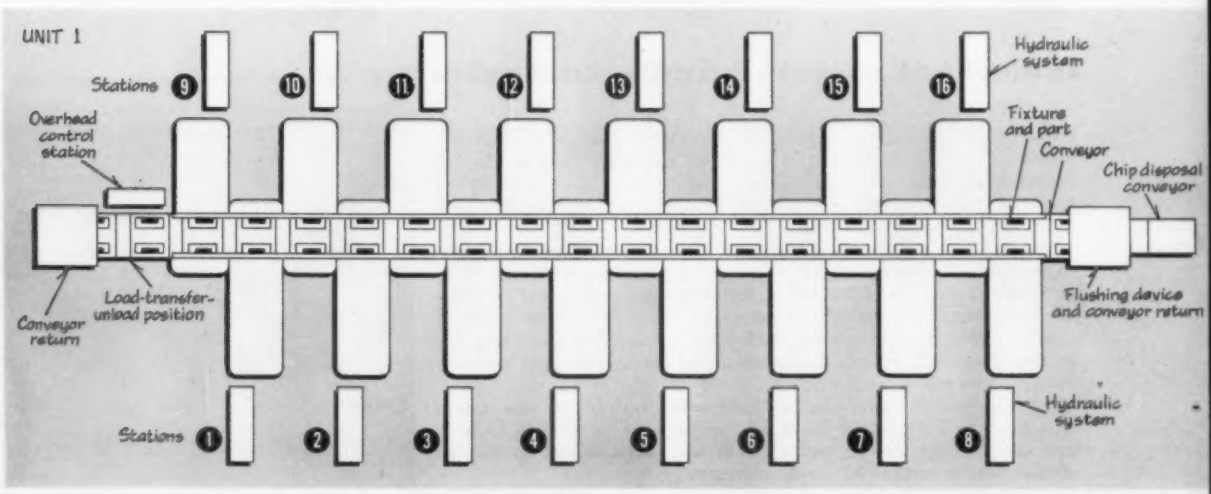
Fig. 1—Automatically 32 operations are performed on this M-14 automatic rifle receiver as it is processed through 32 stations of a two-unit transfer-type machine system. During the machining operations, the original weight of the forging is reduced by about 43 per cent while undergoing milling, drilling, undercutting, and tracer controlled profiling.

APPLYING BUILDING BLOCK UNITS TO MACHINE RIFLE PARTS

Considerable interest is currently being expressed in the building block principle of machine tool construction which facilitates equipment changes in a production line when part designs change. In developing the two-unit transfer type system discussed in this article, the machine tool builder placed major emphasis on equipment standardization and adherence to the building block principle.

By **A. D. GUNDERSON,** Chief Engineer, George Gorton Machine Co., Racine, Wis.

WHEN a user decides to procure a transfer-type machine tool, he knows that he will get a multiple-operation system that will perform at maximum efficiency on the part for which it is designed. However, there is a price for this efficiency since the machine tool system must often be highly specialized in design, and this specialization usually makes it difficult to adapt the system to changes in part design. Therefore, while on the surface the user wants a transfer machine containing a specified number of machining stations, in the back of his mind he also wants a system composed of the same number of individual stations that can be split apart into self-contained machining units, rearranged to



process different parts, and even used as single separate machine tools. This user demand has led to the development of the building block principle of transfer-type machine tool design.

In designing and building a transfer-type machine tool system for the Winchester-Western Div., Olin-Mathieson Chemical Corp., to produce the receiver of the M-14 automatic rifle, the George Gorton Machine Co. utilized the building block principle as much as was practically possible. Adherence to this principle led to the development of a highly satisfactory transfer machine tool system that is capable of attaining all of the user's specifications and still retains the flexibility and individuality of separate machine tools. An additional benefit for the user was that the building block principle provided a means of holding design and build costs to a minimum.

The development of this system stems back to a proposal our company made to Winchester Western several years ago. At that time, we offered a design for a multistation system to machine small parts for a commercial line of rifles. This was a radical departure from Winchester's method of manufacturing parts. Although the proposal was enthusiastically received, the project was not adopted for economic reasons. Later, the M-14 automatic rifle project, a weapon for the NATO forces, entered the picture, and the original proposal was resurrected with a request that it be altered to suit the new requirements.

The M-14 receiver part is a steel forging with a Rockwell C hardness of about 20. Prior to being machined on the Gorton system, many of its exterior surfaces are broached. A sketch of the part as it is ready to be machined by the system is shown in *Fig.* 1. The part measures about 7⅞ inches in length, 1 11/16 inches in width, and 2⅝ inches in depth. It weighs approximately 2 lb 7 oz before machining and is reduced to a weight of about 1 lb 6 oz during processing. Automatically 32 operations are performed on the part by the transfer system and include vertical, horizontal, and angular milling; undercutting; drilling; and automatic tracer controlled profiling and duplicating.

UNIT 1

Station

1—Vertical mill, form-type cutter
2—Horizontal mill, form-type cutter, cross-slide angled at 5 degrees
3—Horizontal mill, form-type cutter, cross-slide angled at 15 degrees
4—Horizontal 3-spindle drill head
5—Horizontal 2-spindle drill head
6—Vertical roughing mill
7—Vertical profile mill with 360 degree tracer unit
8—Vertical mill, T-type undercutter
9—Vertical mill inclined 5 degrees in two directions
10—Horizontal mill, circular saw-type tool
11—Horizontal mill, cross-slide angled at 5 degrees, spindle swiveled 60 degrees, end mill cutter for roughing
12—Same as 11 except ball nose cutter for finishing
13—Horizontal mill, spindle swiveled at 45 degrees, roughing cut
14—Vertical mill, undercuts one side of part
15—Vertical mill, undercuts other side of part
16—Vertical mill, inclined 5 degrees in two directions

UNIT 2

Station

17—Vertical mill, end mill cutter, horizontal box cut
18—Vertical mill, end mill cutter, horizontal box cut
19—Vertical mill, spindle swiveled at 20 degrees, horizontal box cut
20—Vertical mill, inclined at 45 degrees, spindle swiveled at 3½ degrees, woodruff cutter, in and out cycle
21—Vertical mill, spindle swiveled at 45 degrees, vertical box cut
22—Vertical mill, finishes cut of 21
23—Horizontal mill, end mill cutter, vertical box cut
24—Vertical mill, chamfers in horizontal box cut
25—Vertical mill, inclined at 10 degrees, tracer controlled rough cut
26—Vertical mill, inclined at 10 degrees, tracer controlled finish cut
27—Vertical mill, inclined at 10 degrees, horizontal box cut
28—Horizontal mill, spindle swiveled at 10 degrees, roughing cut
29—Vertical mill, finishes cut of 28 from different angle
30—Vertical mill, roughing cut
31—Vertical mill, finish horizontal box cut
32—Horizontal mill, tracer controlled vertical slide movement

▶ Operating Sequence

The layout of the transfer system is shown in *Fig.* 2. The system is composed of two separate transfer-type machine units, each having 16 stations. The steel

Fig. 2—Each unit of the two-unit system is arranged as shown in this diagram. Parts are manually loaded into righthand fixtures at the load-transfer-unload position, indexed through the first eight machining stations, flushed clean of chips at the right end of the line, and conveyed back to the loading position. The parts are then manually transferred to lefthand fixtures, indexed through the remaining eight stations, cleaned, and returned to the loading position. After unloading from the fixtures, the parts are moved to the second unit of the system which is similar in layout with this unit but performs a different sequence of operations.

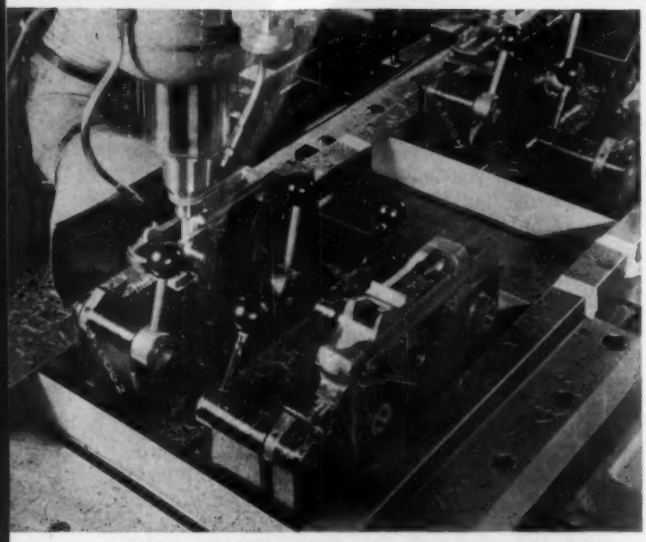


Fig. 3—Close-up view shows parts in the righthand and lefthand fixtures of Unit 1. At this point in the line, the part in the righthand fixture is ready to be indexed into Station 1 while the part in the lefthand fixture is being milled at Station 9. An air exhaust system, such as shown at Station 9, is used at many of the stations to help remove the large amount of chips created by the system.

receiver forging is manually loaded into a transfer platen fixture in an upright position, *Fig.* 3, for automatic indexing through the first eight stations on the operator side of Unit 1.

After a series of milling, drilling, and undercutting operations, the fixture and part reach the far end of Unit 1, *Fig.* 4, pass through a flushing bath to remove chips, and are returned to the loading end of the unit by the return leg of the transfer conveyor which carries the platens under the machining stations. At the loading position, the operator removes the part from the right hand fixture, *Fig.* 3, turns the part upside down, and loads it into the left hand fixture for transfer through the remaining eight stations on this unit.

During the second pass through Unit 1, the part undergoes a series of vertical, horizontal, and angular milling operations and is undercut at three stations. Upon reaching the far end of the unit, the fixture and part are again flushed to remove chips and then returned by conveyor to the loading position. At this point, the part is removed from the fixture and delivered to Unit 2 of the transfer system.

A similar sequence of operations takes place on Unit 2 which is physically laid out the same as Unit 1. A second operator manually loads the part in a righthand fixture for transfer through Stations 17 through 24. However, this time the part is located in the fixture so that it lies on its side. After a series of milling operations, the fixture and part are flushed and conveyor returned to the head end of the unit. The operator manually transfers the part to the lefthand fixture, locating the part in an upright position. After being machined in Stations 25 through 32, the part is flushed, returned to the loading position, and unloaded for transfer to subsequent finishing equipment.

Design Approach

Our approach in designing special machine tool units such as this transfer system is to first sub-

Fig. 4—Over-all view of Unit 1 shows the chip removal equipment at the cleaning end of the line. Some of the air exhaust systems for collecting chips can be seen at the far left. Other metal cuttings are dumped on the chip removal conveyor, shown in the foreground, as the part and fixture make a 180-degree turn for return to the loading position. A third system, between the chip removal conveyor and the end of the unit, flushes the part and fixture to complete the cleaning process.

Fig. 5—Transfer conveyor for Unit 1 is clearly shown in this view taken during construction. The 43 fixture platens, holding two fixtures each, will be secured to the single chain conveyor at each of the small square plates. The large rectangular plates ride between the fixture platens and keep chips from accumulating under the conveyor. The transfer conveyor is indexed by a hydraulic system operating at 600 psi pressure.

divide the system into basic machining units or building blocks which can be constructed as autonomous units in themselves. Each autonomous unit is designed to be as independent in operation as possible, that is, complete with its own control system, hydraulic system, drive motor, etc. The components and parts which make up each autonomous unit are standardized as much as possible to provide interchangeability between units and to minimize the spare part stock for the entire system. A system is then built by combining various autonomous units according to a process flow chart, integrating the units together by means of a suitable transfer mechanism carrying the part fixtures, and installing an over-all system control network.

The advantages to the user of this type of system are many. Any station in the system can be removed from its position without disrupting the operations of the remaining stations. The removed station can be switched with any other station or can be operated independently as a single unit. When part dimensions or configurations change, all units in the system can be rearranged to suit a new process flow plan. If a new operation is required on a part, an old unit can be removed from the line, and a new unit incorporating different tooling can be installed.

For example, in the transfer system for machining the M14 rifle receiver, each of the 32 stations is an autonomous unit consisting of a machine base; a standard height knee that projects across the transfer conveyor travel area and contains the fixture platen locating and clamping mechanism; a cross-slide base plate having either a horizontal or angled face; a traversing mechanism for either unidirectional or cross-compound movement; a machine head having an adjustable feed-rate spindle and which in some cases can be swiveled for angular cutting; a hydraulic system including a reservoir, pump, motor, and valve panel; and a station control panel.

Basically, three different types of machine heads are used in the system. One is a vertical milling spindle with a swivel head which can be used as a straight in and out tool or as a box cycle tool. The second is a horizontal milling spindle having either in and out or box cycle movement. The third is a multiple spindle, horizontal drilling head. Each type of head is standardized, and quite a few parts can be interchanged between the vertical and horizontal milling spindles.

The machine bases have been standardized as much as possible although several different bases are required to accommodate the different types of machine heads. Cross-slide base plates are mounted on top of the bases. These vary from horizontal plates to angled plates of 5 or more degrees. Bolted to the front of the bases are the knees which project across the transfer mechanism.

The hydraulic systems for the stations are located to the rear of the machine bases. Each station has its own system which includes a reservoir, pump, motor, and valve panel. The hydraulic systems are identical except for the stations that do not require a cross-compound movement for a box cycle cut. At these stations, two 4-way valves are eliminated. Other than this variation, any system can be used with any head on the two units. The only compo-

nents shared by two stations are mist-coolant units. In the interest of economy, only 17 units are used to supply the 32 stations.

Transfer Mechanism

The 16 autonomous stations in each system unit are integrated into a production line by the transfer mechanism which holds the fixtures that carry the part from station to station. A view of the transfer mechanism, taken during the construction of Unit 1, is shown in *Fig.* 5. Basically, this mechanism is a continuous-loop, single-chain conveyor which supports 43 fixture platens. Since each platen carries two fixtures, 86 fixtures are used on each unit.

To maintain the desired flexibility of the transfer system, the transfer mechanism is not rigidly affixed to the individual stations. For example, the platens are mounted on the transfer conveyor by means of rubber bushings so that precise alignment of the platen with the station would not be necessary. When a fixture indexes to a station, two shot bolts rise out of the knee and enter guide holes at diagonally opposite corners of the fixture platen. Due to the rubber bushings, alignment can be off as much as 1/16 inch without affecting station operation. The shot bolts lift the platen against two machined stops rigidly affixed to the knee, and hydraulically actuated clamps at the two other diagonal corners securely lock the platen into position for part machining.

This arrangement of positioning the fixture at each station also provides location flexibility between stations and eliminates the necessity of precise alignment between machining heads. As long as the center-to-center distance between the heads is maintained within 1/16 inch, the system will operate satisfactorily.

Control Network

The electrical wiring system for each station is also designed as an entity. All wiring for a station is cabled in one bundle and carried by overhead conduit to a central control cabinet. Here, the wiring is connected to electrical control relays which are arranged in a row for each station. A second control cabinet contains the motor starters for the stations. When a station is removed from the system, the wiring is disconnected from the control cabinet, the cable bundle is pulled from the conduit, and the complete wiring is coiled at the station.

Each station has its own individual control panel by which the machining unit can be switched either to automatic or to manual operation. By switching to manual operation, a maintenance man can check all movements of the station by manipulating the pushbuttons and switches on the panel. During the time a station is on manual control, the rest of the system cannot be indexed.

Each transfer unit is controlled by the machine operator by means of a small master control panel at the load-transfer-unload position, *Fig.* 6. The transfer mechanism is indexed by the operator who simultaneously presses two pushbuttons on the control panel. As soon as the platen is locked into position at each station, the machining head performs its programmed operations independently of other stations. As each head completes its sequence and retracts to home position, it actuates a limit switch which causes a yellow light to illuminate on the control panel. During this time, the operator unloads a completed part from the lefthand fixture, transfers a partially-completed part from the righthand fixture to the lefthand fixture, and loads a new part into the righthand fixture. When all 16 lights have been illuminated, the operator can index the machine again. If one station fails to light, the system cannot be indexed.

Certain stations which use fragile mills and drills are equipped with photoelectric cells for detecting broken tools. When such a tool retracts to home position, the photocell is energized momentarily to

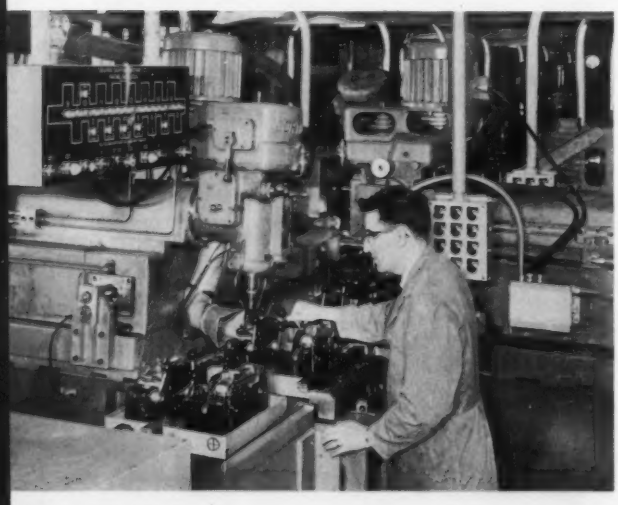


Fig. 6—The operator controls Unit 1 by means of the small master control panel located over the load-transfer-unload position. In the center of the system diagram on the panel are 16 yellow lights, one for each station. After the conveyor is indexed, each station independently performs its machining cycle and illuminates the station light on the control panel when its head returns to home position. When all 16 lights are illuminated, the operator can index the conveyor by simultaneously pressing two pushbuttons on the panel. Unless all lights are on, the conveyor cannot be indexed. The other lights in the diagram are indicators associated with detection equipment for broken tools.

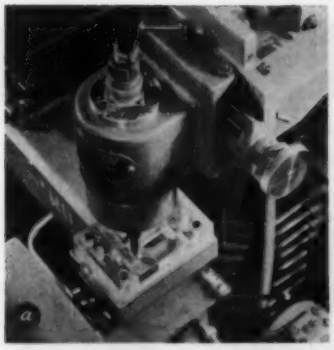
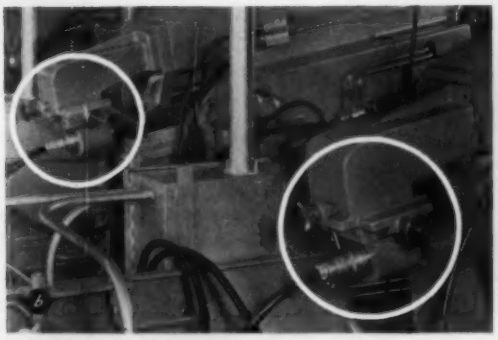
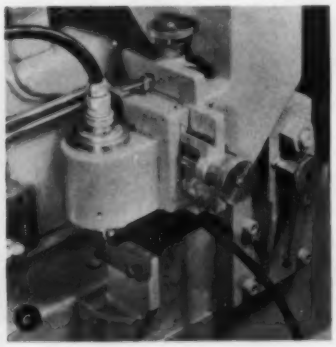


Fig. 7—Tracer controlled profiling is performed at four stations of the 32-station system. At Station 7 of Unit 1, a 360-degree tracer unit *(a)* follows a pattern cut in a plastic block and controls movements of the machine head. Embedded in corners of the plastic block are electrical contacts which initiate circuits to decrease the feedrate of the machine head when cutting corners in the part. At Stations 25 and 26 of Unit 2, electrohydraulic tracer units *(b)* control the in and out movements of the ram slides as the cutting tool develops a profile on the part. The tracer unit at Station 32 of Unit 2 *(c)* controls a vertical slide movement to obtain an angle cut on the part.





check the length. If a tool is broken, a light illuminates on the control panel. Since the cell is not energized continuously, only momentarily, longer life can be expected from the unit.

Two other controls are contained in the operator's control panel. One is a pushbutton for checking the condition of panel lights. When this button is pressed, all lamps illuminate, and unlit lamps mean burnouts. A second control is a key switch for manually controlling the travel of the transfer conveyor. If a jam occurs in the system, the conveyor can be jogged by the key switch.

System Tooling

The tooling on the transfer system is mostly confined to standard milling, drilling, and undercutting operations. Positioning of the cutting tool in relationship to the workpiece is by positive stops and limit switches which control the movement of the various slides and spindle feeds through electrohydraulic valves. However, at one station on Unit 1 and at three stations on Unit 2, electrohydraulic tracer systems are used to control profiling and duplicating operations on the parts.

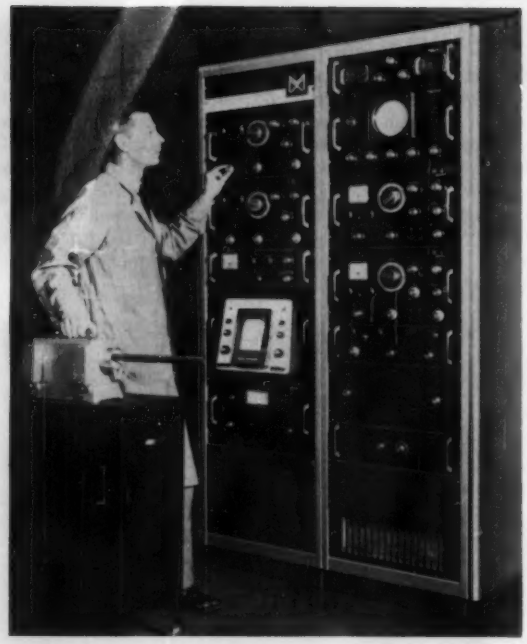
For example, at Station 7 of Unit 1, a 360-degree electrohydraulic tracer system, *Fig.* 7, is used to mill the sight base section of the receiver. The tracer pattern is cut in a plastic block which is mounted to the stationary cross-slide base plate. Since the feedrate of the cutter must be slowed down when milling two 90-degree corners with 3/16-inch radii on the part, a unique control system is built into the plastic block. Imbedded at the two corners of the tracer block are two metallic contact blocks. When the trace stylus reaches these contact blocks, a circuit is set up so that the feedrate of the tool is decreased. After clearing the corner, the tool resumes normal feed. When the stylus finishes tracing, it contacts another block which causes the head to rapid traverse to home position. At the present time, four feedrates are controlled by the contacts in the tracer pattern. However, the system is adaptable so that up to 24 feedrates can be controlled.

On Unit 2, 180-degree electrohydraulic tracer systems are used at Stations 25, 26, and 32. The tracers at Stations 25 and 26 control the in and out movement of the ram slide. The tracer at Station 32 controls the vertical slide movement. Each tracer unit has micrometer adjustment in three directions for fine setup purposes.

When the system is installed in the user's plant, it is planned that each unit will be controlled by one operator who will load, transfer, and unload parts to and from the fixtures and index the system.

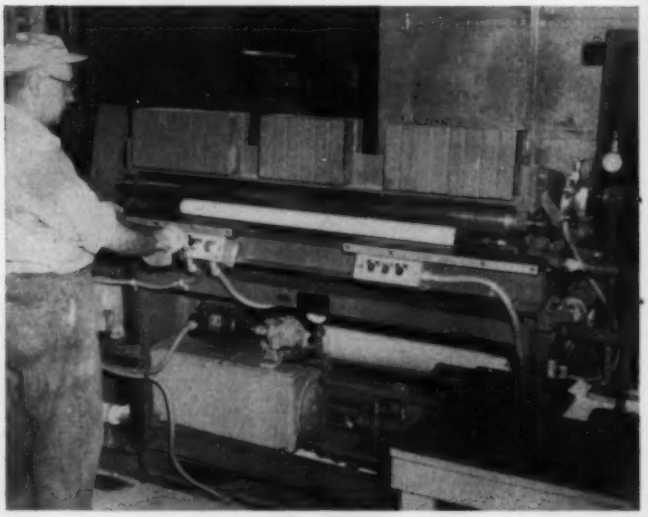
Maintenance and inspection personnel will be assigned to each machine to keep tab of all cutting operations, both as to machine function and quality control of workpieces.

The dwell time for each unit is approximately 45 seconds, and indexing time for the transfer conveyor is about 3 seconds from station to station. Tools in the various heads will be changed on a programmed basis to reduce downtime to a minimum. For this reason, each unit is equipped with three tools for each head—one will be in use and two will be used as spares. The spare tools will be adjusted and set up at a tool board so that fast tool changes can be made on the machines.



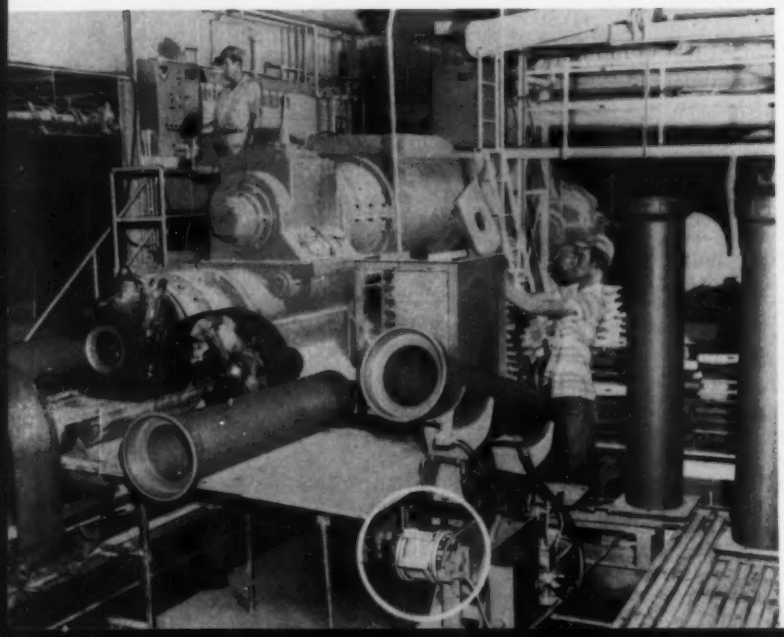
Testing Nonmagnetic Materials

DEFECTS in nonmagnetic rods, tubes, and wires which range in size from 1/16 to 5⅓ inches in diameter can be detected continuously with equipment developed by Magnaflux Corp. In operation, a pair of coils surrounds the material being tested, and eddy currents are induced into the continuously moving rod, tube, or wire by means of an ac current flowing in the coils. Abrupt variations or defects in the material cause changes in the eddy currents. A large differential voltage is developed, amplified, and displayed on a cathode ray tube for visual indication of the defects. The output of the testing equipment can also be connected to a pen recorder, flashing red light, audible signal, or automatic marking devices. The testing unit is shown on the left and the control equipment is shown on the right, housed in cabinets provided by Emcor Ingersoll Products Div., Borg-Warner Corp. The equipment will detect laps, seams, inclusions, voids, concentrated porosity, embrittled areas, slivers, and other types of defects. Instrument may be set so that small defects are not indicated or so that all defects are detected.



Winding Plastic Tubing

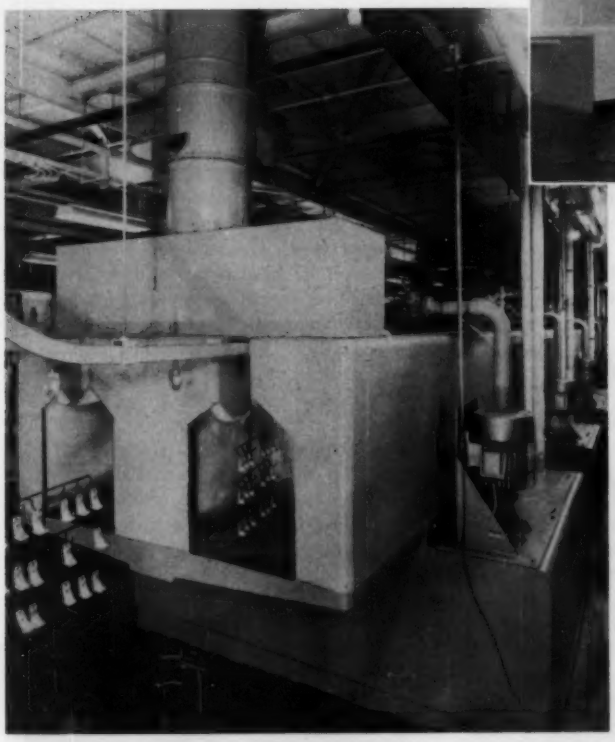
IMPROVEMENTS in quality control and increased production of laminated plastic tubing have resulted from the installation of a special tube winder at the Oaks, Pa., plant of Synthane Corp. The equipment was developed by members of the staff in co-operation with the builder of the machine, Luster-Jordan Mfg. Co. The winder can roll tubing in lengths up to 48 inches and outside diameters up to 10 inches. Winding speed can be varied from 3 inches per minute to 40 feet per minute, depending upon the type and size of tubing being manufactured. To attain high quality laminated rolled tubing, the following factors are accurately controlled: Application of heat, pressure during winding, tension of material being wound, and speed. When compared to previous winding equipment, the winding machine permits greater exposure of impregnated filler to heating elements, increased pressure during winding, and automatic control of tension to produce a dense and homogeneous tube.



Handling Clay Pipe

IN MANUFACTURING clay sewer pipe at Texas Vitrified Pipe Co., Mineral Wells, Tex., stiff clay is extruded, formed, trimmed, and scarified by the equipment shown in the left half of this picture. The fragile pipe is then gently rolled into a vacuum tray, center, where it is upended onto a pallet for firing in a furnace. At this stage of manufacture, sudden shocks tend to flatten and distort the pipe. Therefore, in designing the upending machine, Pearne & Lacy Machine Co. Inc. used an Ex-Cell-O Corp. torque actuator, circled, to operate the lifting mechanism through a drag-link or crank action. This device smoothed out the lifting motion of the tray and enabled the machine to satisfactorily handle the fragile pipe.

in action

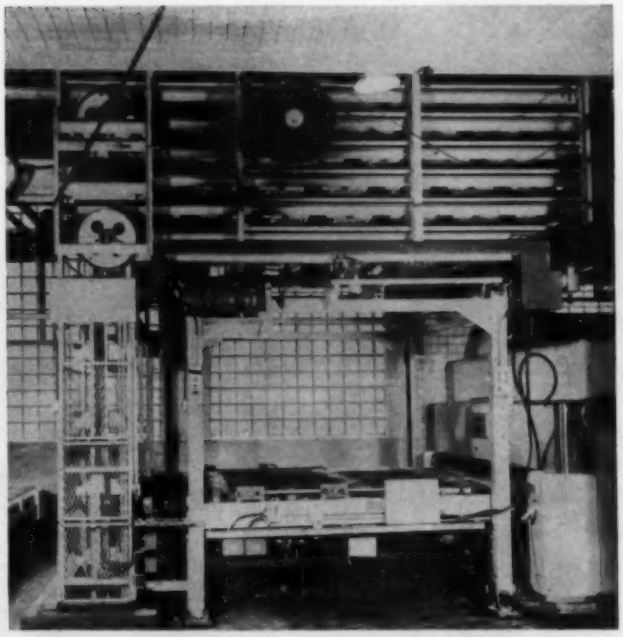


Finishing Industrial Instruments

CLEANING and painting facilities for metal parts can be an attractive part of a plant as evidenced by these views of a finishing line at Foxboro Co. in Foxboro, Mass. Shown on the left is a new 5-stage metal cleaning machine which subjects metal parts to an alkali spray cleaning, a hot water rinse, a treating spray to etch the metal, a cold water rinse, and a chromic acid rinse. From the cleaning machine, the parts pass through an overhead drying oven, inset, which was specially designed to keep floor space clear. This oven is constructed of aluminum sheets over an angle-iron frame and is so light that it is suspended directly from the parts carrying conveyor. After drying, the parts are finished with primer and two coats of lacquer. After each application of paint, the parts pass through overhead drying ovens similar in design to the one shown. All the finishing equipment described was designed and manufactured by the Industrial Equipment Div., R. C. Mahon Co.

Transferring Baked Goods

OVEN unloader and transfer unit, developed by the Food Machinery Div., Baker Perkins Inc., provides either an automatic or a manual method of removing baked goods from the discharge end of a baking oven. When in its lower position as shown, the unit automatically unloads pies from the oven at the right and transfers them to the loading leg, left, of an overhead automatic cooler. As chain conveyors move the pies across the transfer unit, two photoelectric controlled barriers line up the pies in even rows. A third photoelectric device stops the transfer conveyor if a cooler tray is not in position to receive the pies and restarts the conveyor when the tray is properly aligned. When processing baked goods that must be manually unloaded quickly, the unloading and transfer unit can be elevated automatically to an upper position. With the unloader in this position, operators can move floor carriers adjacent to the oven and transfer the baked goods directly to the carriers. The equipment shown is installed at a bakery of Horn & Hardart Co. in New York City.



MULTIPLE FEEDBACK LOOPS CONTROL WEIGH FEEDER

ONE STEP in the manufacture of solid fuel propellants for the missile industry calls for feeding of ammonium perchlorate to a process at precise, predetermined feed rates. Equipment developed by Thayer Scale Corp. to perform this operation includes several automatic control features of interest to manufacturing engineers and operating managers.

The feeding system includes a supply hopper, a gate feeder, a weigh hopper equipped with a load cell and weigh beam, a discharge feeder, and electronic controls. The system also includes a strip chart recorder for recording deviations in feed rates, and a counter that indicates total amounts of product fed.

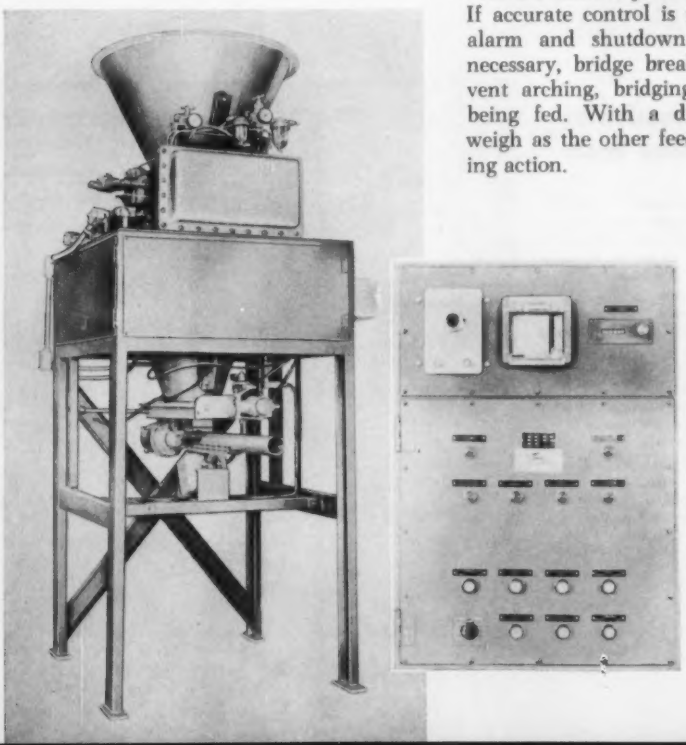
In operation of the system, a poise is first moved along the weigh beam to a position corresponding to the approximate fill weight desired in the weigh hopper. The fill gate is then opened, admitting material from the supply hopper to the weigh hopper. When the approximate selected weight of material is in the weigh hopper, the fill gate is closed. This action occurs when the load cell on the weigh hopper generates a signal that operates a filling relay to close the gate.

The weigh beam on the weigh hopper is then balanced automatically through movement of the poise by a servomotor and gear train connected to the poise leadscrew. When balance is effected, the system is ready to feed material from the weigh hopper to the process at a predetermined rate.

In feeding out, the poise is retracted by the servomotor at a rate determined by the setting of a rate dial. Setting of the dial positions a precision potentiometer that generates a voltage representing a command rate of feed. This voltage is then compared with the voltage from a tachometer driven by the servomotor. The tachometer voltage represents the actual rate of movement of the poise. If the two voltages are different, an error voltage will result. This will cause a change in speed of the servomotor so as to reduce the error voltage to zero. In this manner, the rate of retraction of the poise is held to the preset command rate.

In order to keep the weigh beam balanced, material must be removed from the weigh hopper at a rate corresponding to that called for on the rate dial. This is accomplished through a feeder associated with the weigh hopper. This feeder discharges material in accordance with signals from a differential transformer connected to the weigh beam. If the beam becomes unbalanced, a signal from the differential transformer will call for a higher or lower feeder speed in order to restore the beam to a balanced condition.

Feed rates obtainable from the system range from 50 to 250 pounds per hour at statistical accuracies over a 1-minute period of about 1 per cent K-Sigma. If accurate control is not maintained, an automatic alarm and shutdown circuit is activated. Where necessary, bridge breakers may be supplied to prevent arching, bridging, and rat-holing of material being fed. With a duplex setup, one system can weigh as the other feeds to provide continuous feeding action.



Loss-in-weight type gravimetric feeder includes an upper supply hopper that feeds material to a lower weigh hopper through a feed gate. Preset weights of material admitted to the weigh hopper are discharged at controlled rates by a feeder associated with the weigh hopper. Electronic control panel, inset, may be mounted as far as 300 feet from the equipment.

Teletype machines help cut costly paperwork

A Teletype machine equipped with a simple sprocket-feed mechanism can handle multi-carbon forms as readily as the more familiar plain paper on which messages are transmitted. Thus distances can be bridged not only with information, but with information that is preprocessed, ready to go to work.

Teletype printers handle a wide variety of multi-copy forms. Moreover, the usefulness of this technique can be further extended with Teletype tape punching and reading equipment—which can capture, store and utilize repetitive data to further mechanize paperwork procedures.

Teletype Corporation manufactures this equipment for the Bell System and others who require the finest in data communications equipment.

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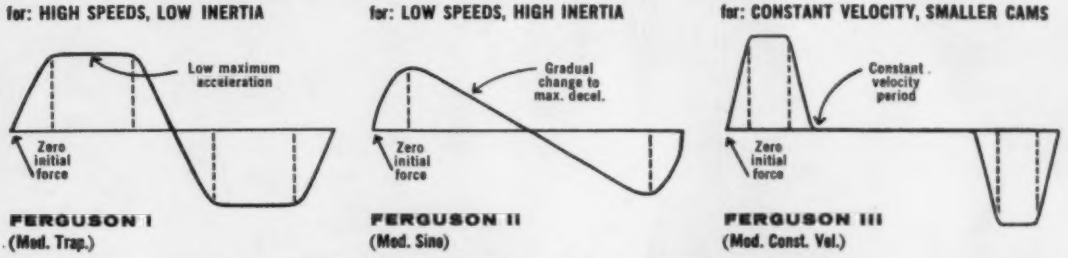
Circle 686 on Page 19

"JOB-SUITED" ACCELERATIONS...

for high speed indexing and precision cams

THE FERGUSON DRIVE
"does what no other indexing device can do."

UNIVERSAL SYSTEM OF CAM DESIGN THEORY PRE-SELECTS ACCELERATION ACCORDING TO THE MOTION NEEDED



Three basic acceleration characteristics employed as dictated by the application

Dynamic design becomes increasingly critical as production machinery attains higher speeds. For this reason Ferguson Machine employs the "*Universal System of Cam Design Theory*" which utilizes the type of cam and acceleration configuration calculated to provide the best combination of operating characteristics for the motion desired.

A pre-selected configuration of the plot of **Acceleration** vs. **Time** is utilized for designing indexing mechanisms, plate, barrel and groove cams and index tables. Cam problems involving unequal times for acceleration and deceleration; compensation for external forces other than inertia; resilient driven members; matching of velocities and low input torque or low impact and centrifugal force requirements are thus taken into consideration and solved.

Movement Time is easily proportioned between **Acceleration Time** and **Deceleration Time** and, when necessary, **Constant Velocity Time.** Established tables based on unity displacement result in design flexibility which facilitates compensation for non-dynamic forces; minimizes vibratory action by considering special characteristics of the inertia load; provides constant velocity periods, etc.

"Job-Suiting" the acceleration characteristic, the only major improvement in the practical application of cams since configuration development itself, is a service much appreciated by Ferguson's customers. You, too, are invited to benefit by the special knowledge Ferguson has accumulated in the field of cam design . . . Send us the facts about any problem related to cam and machine dynamics . . . There's no obligation.

WRITE FOR FREE CATALOG NO. 160—Get full engineering data on the latest in high speed indexing mechanisms, index tables and in-line machine bases. Standard designs employ "Job-Suited" accelerations for your application.

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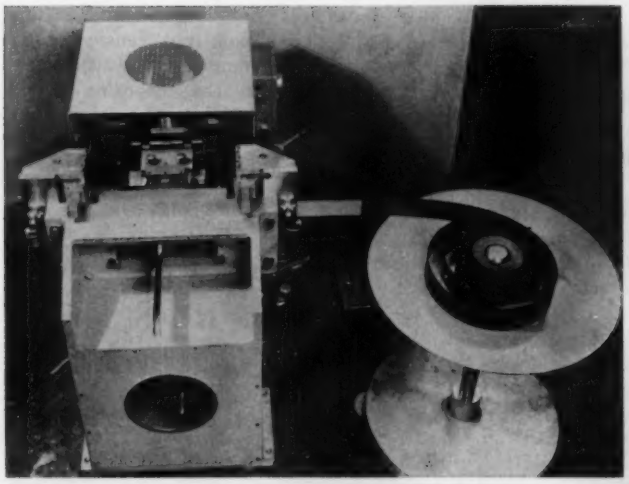
AUTOMATION

new equipment

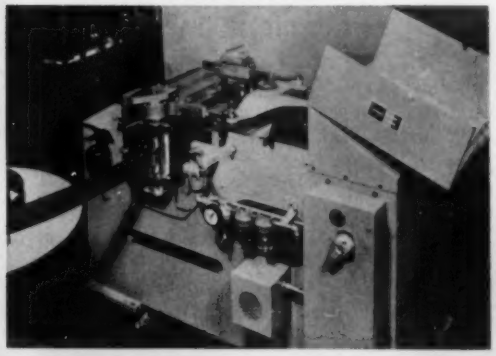
Machines and plant equipment for more automatic operations.

For detailed information and literature, use card on page 19.

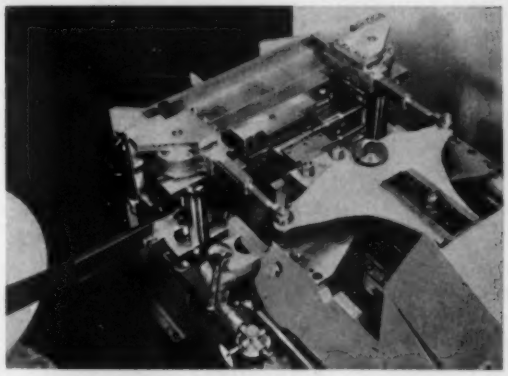


Capable of punching light metal and nonmetallic materials at ultra-high speeds, horizontal press can feed stock up to six inches wide with a four-inch advance. Unit is designed with a vertical crankshaft with flywheel in the base of the machine for low center of gravity. The balanced design distributes vibration more evenly, leading to greater stability at high speeds.

Horizontal press measures about the same size as an office desk, and is designed with a low center of gravity for press stability at high speeds. The guard has been opened in photo to permit view of specially-designed roll feed.



Close-up view of press shows "walking beam" construction of specially developed double roll feed. Each feed is rack driven from the walking beam which is driven by a crank mounted at the upper end of the press shaft.



High Speed Horizontal Press

HORIZONTAL PRESS, developed by **Hudson Div., Emhart Mfg. Co.**, Hudson, N. Y., is capable of handling light gage metals and nonmetallic materials at speeds in excess of 1500 strokes per minute. The unit measures 40 in. high by 25 in. deep by 54 in. over-all length. Press has a capacity of 25 tons. It is designed on a horizontal plane rather than a vertical one, thus providing a lower center of gravity. This factor provides for greater stability at high speeds. The flywheel is centered in the bottom of the press creating a balanced design which distributes vibration more evenly. One advantage of this press is that work will come straight out toward the operator in a chute from the bed of the press. Magnesium is used for the construction of the slide, and laminated plastic for the bearing surface of the slideways, the brake, and clutch. Press has a double roll feed with a drive of "walking beam" construction. Each feed is rack driven from the walking beam which, in turn, is driven by a crank mounted at the upper end of the press shaft. Material up to six inches wide can be handled in increments up to four inches. Roll releases are air operated.

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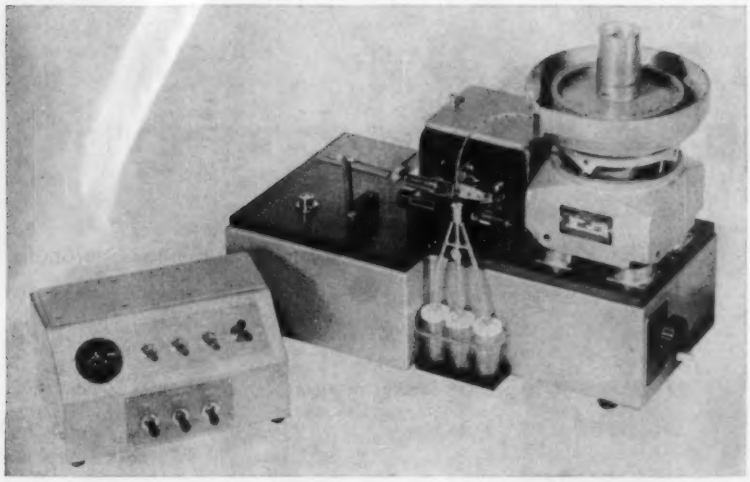

Magnetic Memory Core Handler

Memory core feeder grades and sorts standard 80 or 50 mil miniature ferrite cores, at feed rates in excess of 10,000 cores per hour, in production testing or limited batch testing and laboratory analysis. Feature of the unit is high contact reliability with both probe and contacts made of heat-treated Paliney No. 7 and isolation maintained between the drive and output circuits by the split design of the testing probe. Resistance of the core test circuits is less than ½ ohm and varies less than 100 milliohms during the testing interval. Inductance is less than 3.5 microhenries and varies negligibly during the testing interval. In operation, ungraded cores are loaded in bulk into the input feed tube of the handler, and are mechanically checked for size by the sizing assembly. Oversize cores and broken pieces are rejected and prevented from impairing the uniform feed of properly sized cores to the testing position. A vibrating feeder delivers the cores in single file into the feed chute leading to the testing station. At the end of the feed chute, the core is held in position by a vacuum until the reciprocating probe spears it and carries it to the sorting tubes, whereupon the next core takes its place in the vacuum holder. The reciprocating probe, having passed through the hole in the core, makes electrical contact for two circuits—drive and core output—and the test is made.

Upon completion of the test, external electronic testing equipment or a human operator energizes *Accept* or *Reject* solenoids, and the core is conducted through short sorting tubes to the appropriate receptacles. If, for any reason, the *Accept* or *Reject* solenoids are not activated, the core is automatically deposited in the *No Test* receptacle. Interchangeable vibrating feeder and feed chute assemblies are available, permitting rapid change from one core size to another. Model CH-58 is also available for testing nonstandard core sizes, including the miniature 30 mil memory core. Power requirements are 115 vac, 60 cycles, single phase. **Rese Engineering Inc.**, 731 Arch St., Philadelphia 6, Pa.

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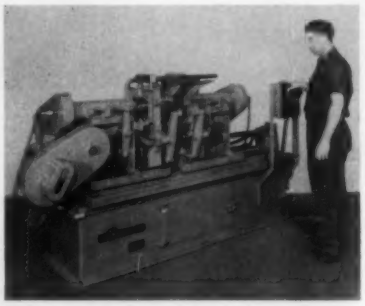

Deburring Machine

Double end deburring machine automatically chamfers the ID, OD, and face of tubular steel parts of various diameters and lengths. Tubing from ¾ to 2¼ inches in diameter and from 2½ to 24 inches long can be deburred by this machine at production rates up to 6000 pieces per hour. Fixtures are designed to permit rapid tool change from one tube diameter to another. A variable speed program shaft synchronizes all automatic operations. This splined shaft actuates tube transfer operations, opens and closes chuck jaws, and operates the work spindles. It is powered by a single 1 hp, 1800 rpm electric motor. Tubes are manually loaded into a vertical magazine in the machine. Walking beam type transfer mechanism automatically transfers the tubes from the magazine to the work station chuck jaws and ejects finished tubes from the machine. When the tubes are clamped in the work station, drum cams drive two opposed deburring tools into each end of the tube. After deburring operations have been completed the drum cams retract the deburring tools, and the finished tube is ejected from the machine. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

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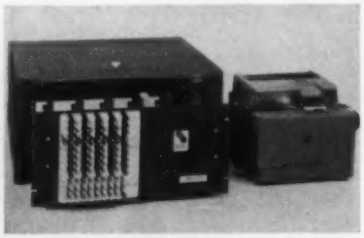

Tape Reader

Photoelectric block-reading tape reader has been designed for machine tool and other applications. Up to eighty bits can be read simultaneously at speeds up to six blocks per second. Model 200 features a solid state rack mounted amplifier section which has a simple plug matrix to promote line by line or block reading. Tape motion is controlled by photoelectric servo. The stop code can be provided either by the equipment used or from any desired hole in the matrix. Use of the sprocket hole as a stop signal results in conventional line by line operation. The reader has only one moving part, the PMI printed drive

Circle 688 on Page 19→

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Plan a happy ending for your automatic packaging.
Buy containers that fit your machinery precisely,
flow through your lines without a stumble or a fluff.

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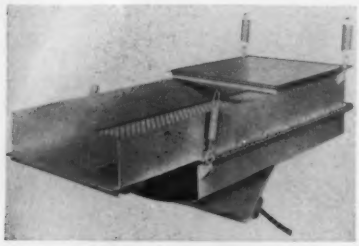
motor. Maintenance has been reduced since no clutches or brakes are required. **Photocircuits Corp.**, 31 Sea Cliff Ave., Glen Cove, N. Y.

Circle 404 on Page 19



Vibrating Screen Feeder

Combination feeder and conveyor can separate mixed loads of solid materials such as sand and gravel, or it can be used for rinsing parts or cooling parts with liquids. The unit moves the material to a collection point and deposits it in separate containers. A pneumatic vibrating drive located under the feeder vibrates both the lower tray and the upper tray which is a porous steel screen. Rapid vibratory action sifts the material such as sand from the gravel in the upper tray. This same action moves both sand and gravel along the trays to individual bins. Intensity and frequency of vibration can be regulated by adjusting the air supply to the vibratory unit. **Cleveland Vibrator Co.**, 2828 Clinton Ave., Cleveland 13, Ohio.

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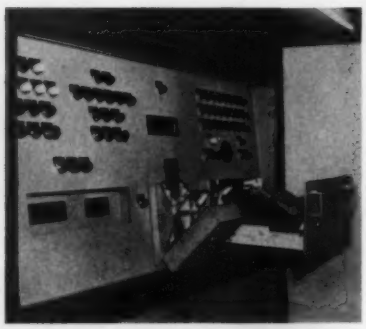

Card Controlled Weighing

System provides electronic control of weighing, proportioning, and batching operations. Ingredients can be liquid, powdered, granulated coarse solids, or slurries. System is particularly applicable to installations handling more than 20 ingredients. Prepunched cards select the desired number of pounds from many possible ingredients, determine batching sequence, control mixing and other processing, storage or additional materials handling. Typical system may be set up as follows: Identification of the ingredient by use of the first three columns on the card; use of the next four columns to indicate the weight of that particular ingredient in hundreds of pounds to the nearest tenth, with the fourth column representing tenths. An interlock on the reader prevents the cycle from starting in the event the card is not properly seated. Related equipment can provide permanent printed records of formula types used and total number of each batch type produced. This system provides accuracies of up to ±0.1 per cent and cuts weighing time by 90 per cent. **Howe Scale Co.**, Rutland, Vt.

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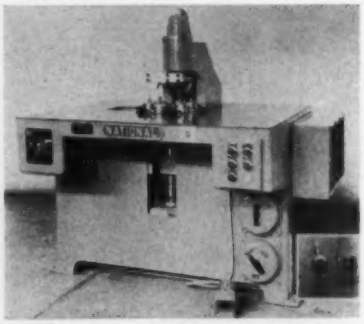

Transistor Welder

Console type transistor welder uses standard key components and can be tooled for either dial feed or single point operation. A table, 3 ft by 4 ft by 32 inches high, forms the top of the unit's base and is designed to accommodate a standard dry box. Two thousand transistors an hour can be produced. The welding transformer is located in the base of the unit. This provides greater compactness and permits a user with a single point machine to convert to dial feed later with minimum changeover. Conversion is accomplished by repositioning the transformer and the welding head, mounting the indexing unit and cutting a hole through the hard-surfaced composition table top. With dial feed operation, an aluminum indexing unit is fitted with quick-change floating dies. Dies for the projection ring weld are machined from standard spot welding electrodes to suit job requirements. The transistor cap and header are self-aligning in the dies. A vacuum ejector that works off the dry box vacuum pump is a feature of the dial feed unit. **National Electric Welding Machines Co.**, 1846 Trumbull St., Bay City, Mich.

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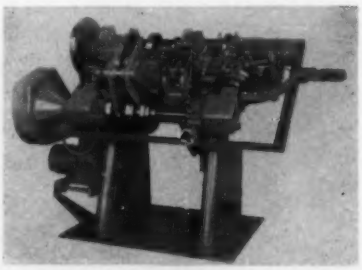

Forming Machine

Ribbon metal and wire stock forming machine can operate at any angle from a horizontal to a vertical position. Model RWI-1 can thus form and eject a part without restriction due to operating angle. Standard equipment includes a variable speed motor, automatic lubrication, and split cams at all forming positions. Design features a form bracket with two vertical motions and dual mounting and a symmetrical press unit which can be mounted on front or rear of metal line. Press unit is rated for four tons, and two units can be mounted. The forming machine can be utilized with automatic receiving equipment including conveyors, rotary table stacking units, horizontal arbor for applying adhesives, etc. The machine will accept feed lengths up to 8½ inches, wire diameter to 3/32 inch, and ribbon width stock to 1½ inches. It can turn out 75-300 parts per minute with a variable speed drive. Production can be increased to 400 parts per minute by incorporating high speed cams and short feed. **Baird Machine Co.**, 1700 Stratford Ave., Stratford, Conn.

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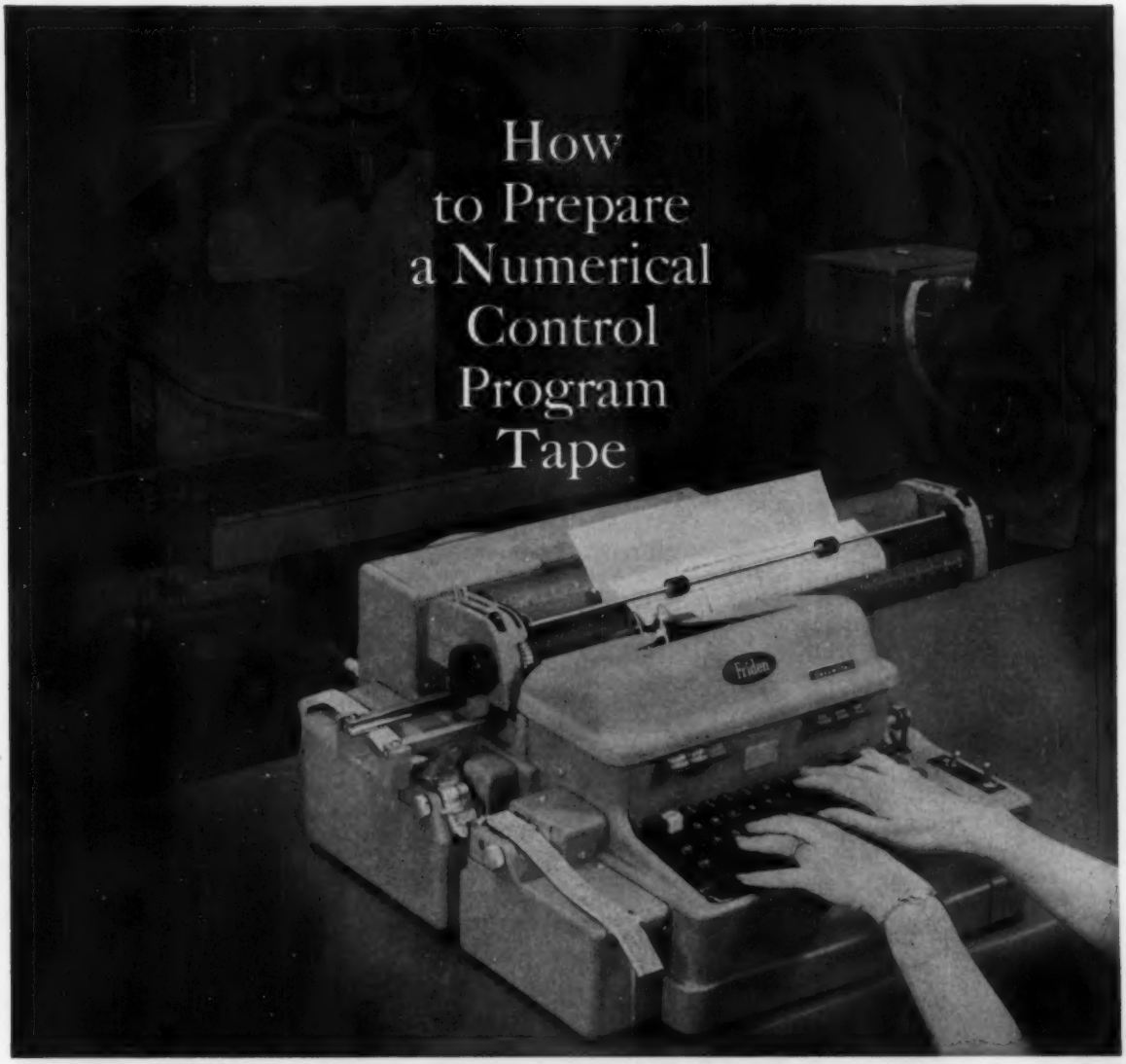

(An Industrial Revolution In One Easy Lesson)

This is the Friden Flexowriter: a heavy-duty, automatic electric typewriter, with an integral tape punch and tape reader. There is no faster, easier or better device for coding paper tapes. Here's why:

1) The keyboard is standard; any competent typist can master the other controls in less than an hour.
2) The operator types a visual proof as she makes the tape; errors are caught and corrected immediately.
3) Automatic parity check guarantees against mis-coding.
4) Tapes can be double-checked (or quickly duplicated) by running them through the reader.

For all these reasons, the great majority of machine tool manufacturers either *have standardized* or *are now standardizing* on the Friden tape reader with Flexowriter input. Take it from the pioneers in numerical control: punched paper tape is the best input; and in punched paper tape. Friden is by far the leader.

In business, communications, graphic arts, and now in heavy industry, Friden source data systems build a new concept. We call it PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it. ©1960 FRIDEN, INC.

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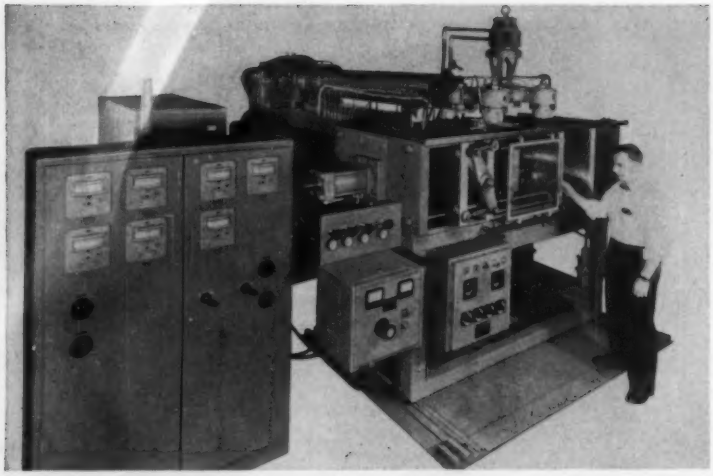
Circle 689 on Page 19



Plastic Molding Machine

Molding machine utilizes a two-stage cycle, with only linear motion. The 450 Series manifold, designed for minimum maintenance, is built to handle the large parisons used in blow molding large items. A rotary valve in the manifold feeds material to molding stations with no material cutoff at any point. Manifold passages have removable ends for cleanout and inspection. Heated torpedoes maintain correct material temperature while deflecting material to the molding stations. Blowing is normally done through the head; however, blowing through needles is also possible. Parts are cooled continuously, except for the split-second required for mold closure. **Auto-Blow Corp., Subsidiary, National Cleveland Corp.**, 409 Bishop Ave., Bridgeport, Conn.

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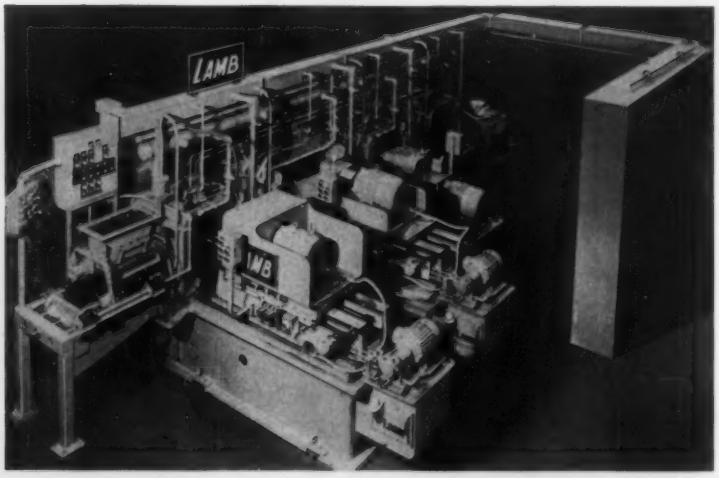

In-Line Transfer Machine

Six-station in-line transfer machine incorporates a hopper to meter and feed steering tie rod adjustable sleeves to the transfer mechanism. There are four machining stations plus load and unload stations. Operations performed are core drill both ends, mill slots both ends, tap one end, tap opposite end. Production rate is 625 pieces per hour at 100 per cent efficiency. The hopper loads four parts at a time. Each part is carried in a pair of U-brackets that are mounted on a heavy roller chain conveyor. The chain is driven by an indexing mechanism that utilizes a cam actuated limit switch for timing index and brake. Guide rails maintain side-to-side part position and spring tension bars prevent parts from jumping out of the transfer brackets. At each work station the parts are lifted and hydraulically clamped into locating V-blocks for positive positioning.

Work is performed wet. Machine fixtures and main bases are well drafted for good coolant and chip disposal to central systems. Standard slide and tapping units perform all machining functions. Lubrication is automatic including oil mist to heads and conveyor chain. Electrical interlocks assure proper sequencing. **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit 34, Mich.

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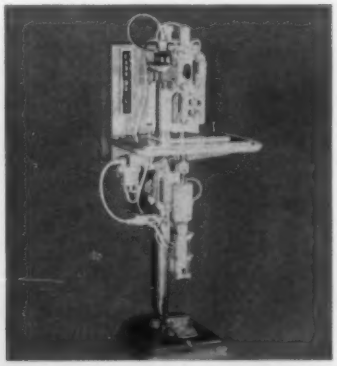

Circuit Board Drill

Electronic circuit board drill is capable of putting holes in copper-clad plastic laminate while panels are stacked six deep. An overhead stylus engages a template on top of the stack while the panels are drilled from below. The unit also prepares the stylus-template which is used to locate the stack of panels. Using a sample panel and with an optical target scope mounted in the stylus-head, each hole is target-drilled and countersunk in the template. The scope is then removed and the stylus-adapter is put into place. The template is placed on a stack of six etched panels and dowel-located in two places by T-pins. The stack is maneuvered on

15 THOUSANDTHS OF A SECOND IS A VERY LONG TIME

It's much faster than you can wink an eye, yet time enough for Bell Laboratories' new high-speed switching terminal to transfer your voice to another channel while you are talking by telephone.

The new terminal—recently introduced on the transatlantic cable—uses the idle time in the conversations of talkers on a group of channels to provide paths for other talkers. This time-sharing technique, called Time Assignment Speech Interpolation, permits the sending of 72 simultaneous phone conversations over this deep-sea system where only 36 could be sent before.

TASI takes advantage of the fact that in a normal telephone conversation you actually talk less than half the time. You do not talk when you are listening, and even when you do talk there are pauses between sentences, words, and syllables. When there are more talkers than channels, TASI puts this idle time to use.

Scanning each circuit thousands of times a second, TASI instantly notices when you aren't talking, then quickly switches in someone who *is*. TASI also notices when you resume talking, immediately finds a channel not in use that moment and switches you to it. Your voice may be switched many times during a single conversation in a time too fast—about 15 milliseconds—for your ear to perceive.

The TASI switching terminal was rendered feasible by the transistor—an invention of Bell Telephone Laboratories. More than 16,000 transistors are employed to achieve the compact, dependable, high-speed circuitry required. TASI is another example of how Bell Laboratories works to keep your telephone service the world's finest.

BELL TELEPHONE LABORATORIES

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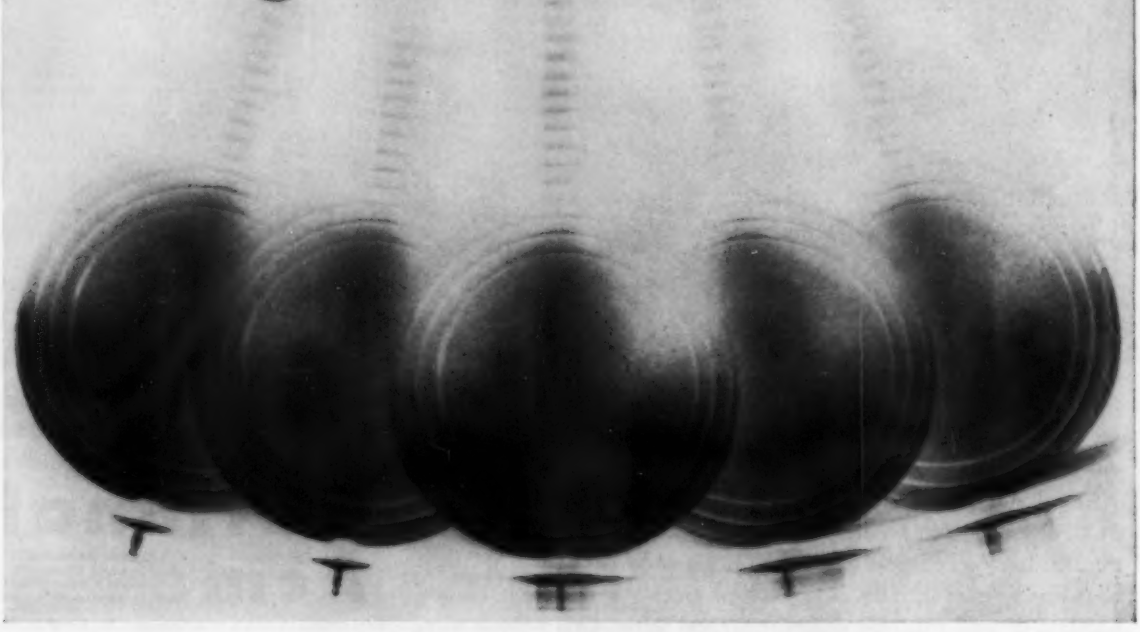

National Acme's SL2X limit switch

doubly certified

explosion proof

SWITCH SHOWN ACTUAL SIZE

Specify National Acme's SL2X . . . and eliminate limit switching problems under explosive conditions. Tested and certified "explosion-proof" by both Underwriters' Laboratories and the Bureau of Mines, the SL2X is specifically designed for use in the mining, chemical, process industries . . . anywhere explosions cannot be tolerated. Latest of National Acme's dependable SL2 "Machine Life" Limit Switches, the SL2X also offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (12½ lbs. at 1½" radius). Get all the details on this new standard of limit switching dependability and safety. Call, write or wire.

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Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Circle 690 on Page 19

the table to bring the stylus over the selected countersunk holes in the template. Depression of a foot switch causes the stylus to travel down and engage the countersunk hole, pinning the stack together under 30 to 60 lb of force. The drill head then travels to *Up* position and returns, drilling through the six boards. This machine is self-contained and can drill metal as well as plastic. It features a "woodpecker" action available for use with drills under 0.030 inch in diameter. The drill head runs at 2500 to 1500 rpm and features hydraulically controlled feed. **Curt Carr Co.**, P. O. Box 1205, Pomona, Calif.

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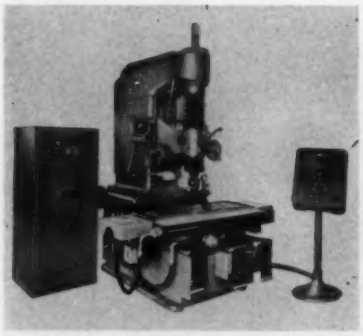


Jig Borer

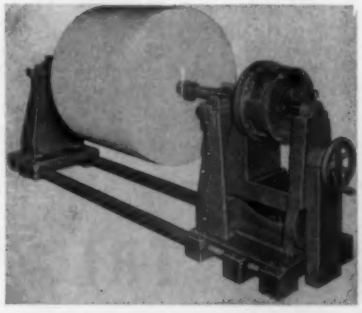
Numerically controlled jig borer, Model 65, features accuracy to ten-thousandths with high traversing speed. Table and saddle traverse simultaneously to reach each position in the shortest possible time. Specifications of the device are as follows: Table size—18 by 52 inches, longitudinal movement—28 inches, cross movement—18 inches, vertical capacity—27½ inches. Positioning accuracy is obtained from ultraprecision linear transducers. Electric signals give the location of the slides without physical contact. The table and saddle are driven by hydraulic cylinders. The work piece is located under the spindle by turning the micrometer dials of the zero offset. Rapid traverse for setup purposes is controlled directly from push buttons. The control system used on Model 65 reads the tape by low pressure air. An entire block of tape containing all necessary information for a given position is read simultaneously. One inch wide, eight-channel tape is used with provisions for auxiliary functions. **W. B. Knight Machinery Co.**, 3920 W. Pine Blvd., St. Louis 8, Mo.

Circle 412 on Page 19

Tramp Iron Separator

Magnetic separator is designed for removing tramp iron and iron bearing slag from raw crushed slag feed. It incorporates an SE Series self-cleaning oil filled and oil cooled rectangular double gap suspended magnet. Arranged for cross belt operation, the separator can be mounted 15 inches above the belt. The unit is complete with reversible motor to discharge to either side of the main conveyor. Magnets are available in all standard belt widths, in seven strengths for self-cleaning or non-self cleaning installations. Heart of the magnet is the space winding feature and oil cooling of the coil. **Magnetic Engineering and Manufacturing Co.**, 840 Van Houten Ave., Clifton, N. J.

Circle 413 on Page 19



Unwind and Rewind Unit

Line of unwind and rewind equipment is designed to meet web processor's needs. Turret-type, heavy-duty, and light-duty units are included. The heavy-duty units, shaft or shaftless, accommodate 48, 60, and 72-inch diameter rolls and operate at speeds of over 1500 fpm. Heavy-duty unwinds and rewinds feature air-operated, water-cooled brakes and adjustable arms to accommodate various web stock widths. Constant tension and web guiding is available. Light-duty unwinds feature manual braking and accurate side lay. Web guiding is optional. Model TO-24, a turret-type unwind stand, features a flying splice action that automatically and instantaneously splices a new roll of stock onto a moving web, without stopping or slowing down the process. Model TO-24R rewind stand features a flying knife action that instantaneously transfers the moving web to a new core. **Stanford Engineering Co.**, Salem, Ill.

Circle 414 on Page 19

Tape Converter

Any five, six, seven, or eight-channel code system may be converted, one to another, by means of this tape code converter. Uses for the converter include tapes for graphotype address plate embossing, computer input, and machine tool control. It can also be obtained with a special punch and reader which will enable tapes to be converted for teletypesetter operation. The converter is preset at the factory by a plug-type control panel. In operation, a *Power* switch puts the converter in a ready condition; a *Tape feed* switch causes a tape lead to be fed out; then a *Start read* toggle, when actuated and released, will cause tape reading to begin. Simultaneously, code con-

NOW...

automatic contouring without a computer

New General Electric Mark Century numerical control now makes *computerless programming* a reality for most metalworking operations . . . including all radial and straight-line machining.

This new control system takes punched-tape input from a standard automatic typewriter . . . reads and interprets it . . . and automatically commands the machine to carry out a complete machining cycle. Producing more than 85% of industry's machined parts can be as simple as that—*with no computer or other special equipment necessary!*

Contouring or absolute positioning—Mark Century numerical control comes in a compact, "building-block" package with a choice of: positioning to absolute co-ordinates; contouring; or a combination of the two. Each is available as a 2-, 3-, 4-, or 5-motion system.

Solid-state devices, modular construction—Completely static, high-speed logic circuits mean long life and dependable performance. New General Electric plug-in, modular construction simplifies maintenance and inspection.

Another member of the G-E program control family—Mark Century control is the newest addition to General Electric's complete line. It supplements the industry-renowned Mark series of job-proved, low-cost numerical positioning control to bring *computerless programming* to America's metalworking industry.

See your machinery builder or G-E Sales Engineer today, and find out how General Electric numerical control can help you increase productivity and cut machining costs. Or, write for new bulletin to General Electric Company, Schenectady 5, New York. Specialty Control Dept., Waynesboro, Va. 795-11

Progress Is Our Most Important Product

GENERAL ELECTRIC

NEW MARK CENTURY

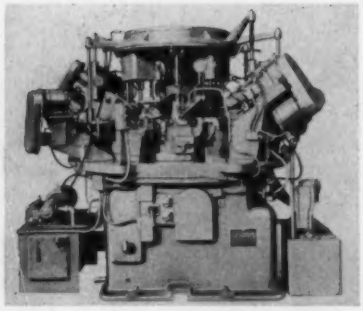
NUMERICAL CONTROL
FOR AUTOMATION

See General Electric numerical control at the Machine Tool Exposition and the Production Engineering Show, September 6—16, 1960, Chicago, Illinois.

NUMERICAL CONTROL

version occurs through the control panel and codes are punched in the output tape. Another switch stops the converter. Indicating lights located near the switches signal when the power is on and when a parity error has occurred. Tapes are read at 1180 codes per minute, and widths of 11/16, 7/8, or 1 inch are acceptable. Parity check is a standard feature, as well as a built-in code check to insure that an output code is punched for every code read. **Friden Inc.**, 421 University Ave., Rochester 7, N. Y.

Circle 415 on Page 19



Center-Column Machine

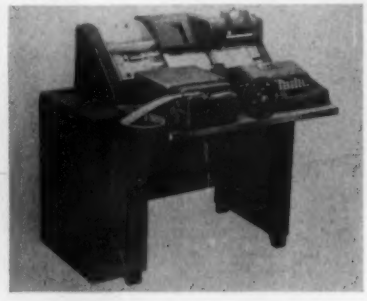
Twenty-three individual operations, including drilling, spot facing, countersinking, reaming, and tapping are performed on four-barrel carburetor air horns by a vertical center-column type production machine. Model 67S-247 has a vertical mushroom head which actuates seven rack-fed platen-mounted auxiliary heads. Parts are cycled twice around the table. Machine is equipped with six-station automatic index and produces 375 pieces per hour. Load and transfer type fixtures are used, with one equalizing lever to clamp both parts. The operator removes a finished part from the transfer position, transfers a part from the load to the transfer position, and inserts an unfinished part in load position. An automatic safety switch checks the clamping. If both parts are not properly clamped, the table will not index and parts as well as tooling are protected. Standard production units are incorporated by the machine to eliminate model changeover problems. **Morris Machine Tool Co.**, 2011 Eastern Ave., Cincinnati 2, Ohio.

Circle 416 on Page 19

Multiple Slide Press

Combination multiple slide and transfer press can blank, pierce, form, and bend in one single continuous operation at speeds up to 100 strokes per minute. It is available in capacities of three and nine tons. Feature of the unit is the distortion-free primary blanking which provides accuracy. Tolerances on finished parts are not dependent on accurate feeding of strip since the blank is separated from the strip at the first station and positively held for subsequent operations so that there is no bending or twisting of the stock. Another feature is that all tool holders are adjustable for height, and changes to new parts are easily made. Each stage of the press is completely separate, so that each tool, guide, and slide is accessible without disturbing the settings of adjacent stations. **E. W. Bliss Co.**, 1375 Raff Rd., S. W., Canton 10, Ohio.

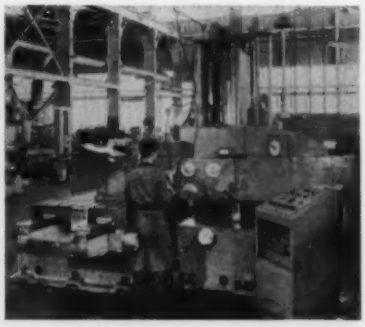
Circle 417 on Page 19



Tape to Card Converter

Code punched tape to card converter, Model C750, is engineered for attachment to any IBM Model 024 or 026 card punch. It will process multiple card layouts, including complex header card and detail card programs with automatic sequence checking and error routines at speeds of 20 characters per second with the 024, and 18 characters per second with the 026. Machine enables any five, six, seven, or eight channel punched tape to be used as input to punched card data processing systems. Plugboard wiring entirely controls the decoding. Model C750 consists of a tape reader and a control module connected by a cable. The control module houses all converting and programming circuits, and the removable programming plugboard. Standard feature of the machine is parity checking of both odd-bit and even-bit tape code systems. **Systematics, Div., General Transistor Corp.**, Redondo Beach, Calif.

Circle 418 on Page 19



Boring Mill

Horizontal boring mill can be controlled by the use of only two fingers. Clock-type dials and variable traverse rates are controlled through a portable pendant. This pendant provides for the two-finger control over all traverse and feed motions of head, spindle, table, and saddle. Machine designated Dynamill is available in 3, 4, and 5-inch spindle sizes. It can be supplied in five standard table sizes ranging from 36 by 60 inches up to 60 by 132 inches, in five standard bed lengths from 60 up to 144 inches, and in four ranges of head vertical travel from 50 to 86 inches. Feed rate can be increased or decreased while the tool is in the cut. Dynamill has variable feed rates ranging from 0 to 0.125 inch per revolution and 0 to 108 inches per minute.

New Tally Tape Console cuts punched tape preparation time by 600% on Hound Dog missile

Last fall, the first production model of the new Tally Tape Console was delivered to North American Aviation's Missile Division to speed the preparation of punched paper tapes. The tapes in turn program both production and preflight missile checkout systems on SAC's Hound Dog missile.

Before the Tally Tape Console was installed North American Missile Division engineers took 30 hours to make and absolutely verify a 400-foot programming tape. To make and absolutely verify a duplicate copy of the tape required an additional 75 minutes.

The Results

Now, North American Missile Division engineers using the new Tally Model 150 Tape Preparation and Editing Console make 400-foot tapes in three to four hours. Duplicate tapes are made in only 37 minutes. And Tally tapes are *guaranteed* error free.

Tally/Seattle is pleased to have played a significant role in North American's pace setting GAM-77 program which took only thirty months from design to flight of production models by SAC crews.

Tally's Tape Console simplifies and automates punched paper tape production

It features tape-to-tape duplication and verification at 60 characters per second. A keyboard visual display and shift register reduces error and operator fatigue in both punching and verifying modes. Tape corrections can be made without overpunching or splicing.

The Tally Tape Console is another new product from a creative engineering team specializing in punched paper tape technology. Your nearby Tally engineering representative can provide you with complete technical information on the Tally Tape Console or you may write directly to Dept. U6.

TALLY

REGISTER CORPORATION

1310 Mercer Street
Seattle, Washington
Phone: MAin 4-0760

Circle 692 on Page 19

Tape control can be easily added to head and table at any time. Where numerical controls are applied, the dial measuring system provides an accurate read-back making it possible to check the reliability of the tape input data. The head and table are actuated by precision racks and have a repetitive accuracy of 0.002 inch. Rotating turret mounting four buttons on the pendant control all directions of movement of the head, table, saddle, and spindle. A planetary drive makes possible 28 spindle speeds. For tapping operations the spindle may be reversed instantly at any time by throwing a simple toggle switch mounted on the head. Hardened bearing ways are precision-ground steel with a 0.0015-inch hard chrome plate. Full automatic lubrication with forced-feed is provided. The Dynamill can be supplied with all standard attachments for continuous feed facing with infinitely variable feeds, right angle milling, thread-cutting, and contouring. Built-in or auxiliary tables are also available. **Bullard Co.**, Bridgeport 9, Conn.

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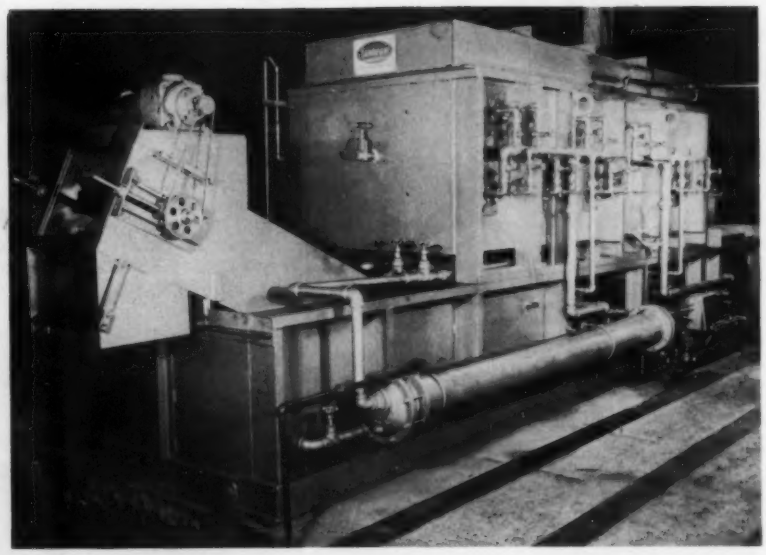
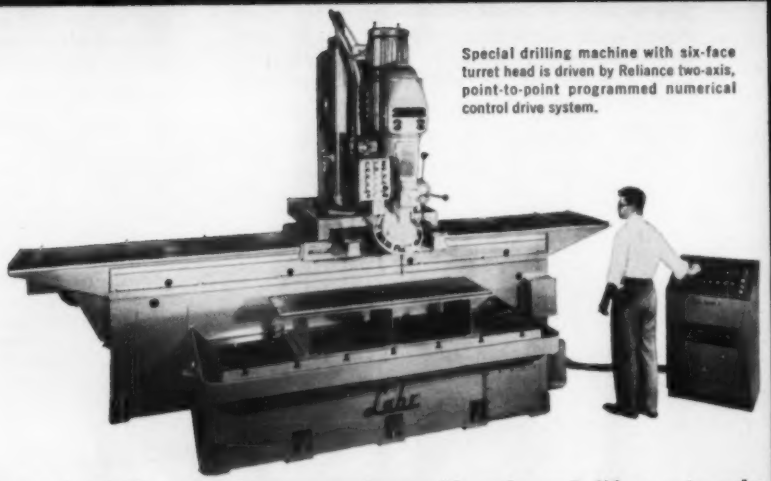


Shuffle Hearth Furnace

Designed for continuous controlled atmosphere heat treating and quenching, shuffle hearth furnace can be used for hardening and carbo-nitriding within an operating range of 1400 to 1800 F. Especially adaptable to processing small parts such as fasteners, nails, and bearing parts, it can be built in a range of sizes which will process from 50 to 1200 lb per hr. Use of muffles enables work to be processed immediately upon reaching operating temperature. Muffles are over and under fired with closely spaced nozzle mix burners to give radi-

RELIANCE PROGRAMMED NUMERICAL CONTROL

a complete system for automatic positioning of machine tools



Special drilling machine with six-face turret head is driven by Reliance two-axis, point-to-point programmed numerical control drive system.

Cutting the costs of lead time and expensive tooling, as well as maintaining high accuracy, Reliance Programmed Numerical Control brings to industry a complete, engineered positioning system. Using resolvers, or resolvers with scales and sliders, extremely accurate position information is compared with the numerical input, and the difference used to drive the positioning motors.

ator-like even heating effect. Once the work has been charged, it is not handled again until quenched and carried from the quench tank by a conveyor. All types of standard atmosphere generators may be used with this furnace. Insulation is 11 inches of castable material. **Sunbeam Equipment Corp.**, 180 Mercer Street, Meadville, Pa.

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Dipping Machine

Machine applies varnish insulation to parts such as stators and electric motor windings. Unit is designed so the dip tank moves upward to immerse the parts, then recedes so the parts continue onward. The dip tank moves up a maximum of 13 inches, and allows immersion up to 9 inches. This is controlled by a photoelectric cell. A constant level of varnish is maintained at all times. The servicing conveyor can be halted over the tank to allow a longer period of work drainage if it is necessary.

The machine consists of two tanks, one over the other, which are built into an operating unit that includes hydraulic and varnish circulating systems. In operation, a conveyor from a preheat oven runs over the upper or dip tank of the system and as the conveyor stops directly over the dip tank, it triggers a limit switch. The upper tank, which is in a lowered position, rises to immerse the work and simultaneously, the lower or varnish storage tank moves downward. After immersion, the upper tank lowers automatically and the lower tank rises, acting as a counterweight in the movement and keeping the varnish in the dip tank at a proper level. **Industrial Equipment Div., R. C. Mahon Co.**, 6565 E. Eight Mile Rd., Detroit 34, Mich.

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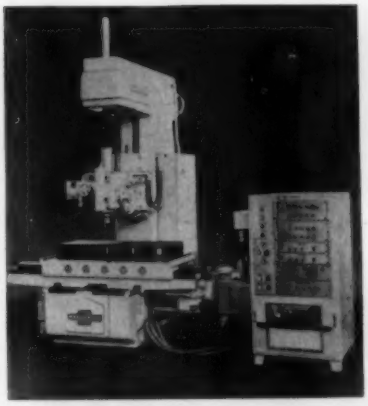

Drilling Machine

Numerically controlled drilling machine is available for continuous production or short-run jobs. Equipped with Cincinnati Milling's Acramatic analog type two-axis positioning control, this heavy-duty machine allows fully automatic direct programming of all machining functions such as table positioning, speeds, feed rates, and tool changes. This control enables complete program shift (zero shift) in two axes over a full 20 by 48-inch area. Ac-

The Reliance drive provides fast, high accuracy positioning by operating the motors at high speed until the final position is approached. The motors are then slowed down in proportion to the distance from the programmed point, stopping at the exact position. Any number of linear or rotary motions can be controlled simultaneously or individually for completely automatic operation. Provision can also be made for auxiliary functions such as turret selection, clamping, and coolant control.

Reliance Programmed Numerical Control utilizes 8 channel tape or dial selector switches for input. Numerical indicator tubes can be provided for readout.

Here is what you get when you buy Reliance:

- Absolute system—operates from zero reference with no cumulative error.
- Positions from either direction.
- Uses standard machine tool tape, with standard tape processing and reading equipment.
- High Accuracy—electrical accuracy of ± .0001 inch and repeatability of .00001 inch can be achieved.
- Powered by Reliance Super 'T' D-c. servo motors . . . small diameter, low inertia, dynamic response.

Reliance systems are of industrial construction, and are sold and serviced by a nationwide organization. For more productive machine time, for greater machine utilization, you'll want to know the complete facts about Reliance Programmed Numerical Control. Call your nearest Reliance Sales Engineer, or write direct.

See the Reliance Numerical Control in operation at the Production Engineering Show, Navy Pier, Chicago, Ill., Sept. 6-16, Booth 411-417

D-1678

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 269A CLEVELAND 17, OHIO

Canadian Division: Toronto, Ontario

Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Circle 693 on Page 19

curate to ±0.001 inch, this machine offers high part-to-part dimensional uniformity with repeatability of ±0.0002 inch. Features include: Signal light for tool change, 30-1800 rpm spindle speed range (in 16 increments), 0.002 inch to 0.030 inch per revolution spindle feed range (in 8 increments), 230 ipm maximum table positioning speed. Drives include standard spindle drive (5 hp-1200 rpm), oil pump motor (3 hp-1200 rpm), or cutting fluid pump motor (1/10 hp-3600 rpm). **Heald Machine Co.**, 13 New Bond St., Worcester, 6, Mass.

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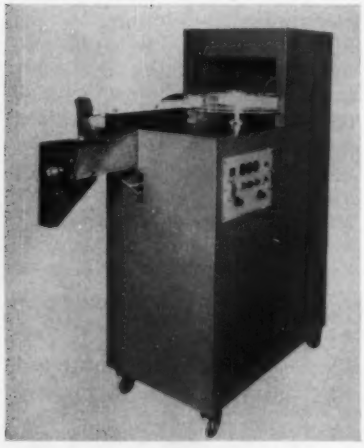

Counting Machine

Electronic counting machine has been designed for application to the food, drug, and candy industries. Other applications include small hardware items, electronic components, and odd shaped items such as drapery hardware. In operation, the items to be counted and packaged are placed in the supply hopper on top of the counting machine. The desired count per package or bottle is then selected merely by turning a set of three dials on the face of the electronic counting instrument. Any quantity up to 1000 may be selected. Various types of packaging equipment can be used in combination with this counting machine and cycled automatically by it. Automatic bottle conveyors, cartoning machines, and heat-sealing wrapping machines are easily employed to count and package in one automatic operation. Changeover from one item to another can be effected in sixty seconds. **Delta Engineering Corp.**, 126 W. Emerson St., Melrose 76, Mass.

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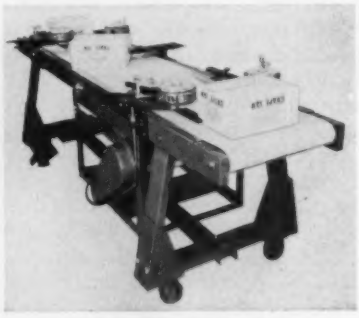

Four-Side Case Marker

Marking product identification on all four sides of shipping cases during the packaging operation is function of this device. Process employed involves use of a belt conveyor, one or more turners, adjustable side guides, and a set of friction-powered Rolacoder imprinters. Different setups are available. One setup, shown, provides for marking all four sides on the conveyor. Another calls for imprinting two sides of cases in the case sealer and the other two sides upon leaving the case sealer. Variations in arrangement of turners and guides permits delivery of marked cases with either sides or ends of cases leading. **Adolph Gottscho Inc.**, Hillside 5, N. J.

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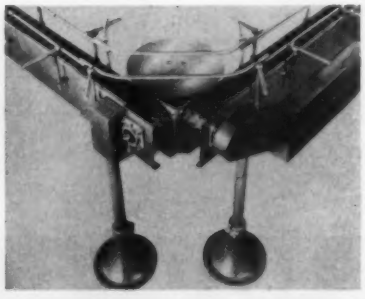

Turntable

Turntable is particularly suitable for the transferring of bottles, cans, jars, and small parts and packages. It is designed for use with Unibilt Table Top Chain conveyors and is mounted to and driven by a conveyor. Constructed with self-aligning ball bearing units, precision bevel gears, and chain drive, the turntable is available in plain or stainless steel and can be supplied with guard rails. It can be driven from the drive end, take-up end, or intermediate location of the conveyor. **Conveyor Specialty Co. Inc.**, North Quincy, Mass.

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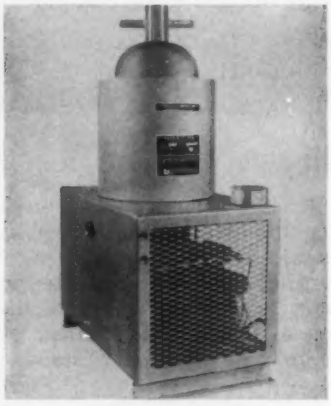

Air Dryer

Refrigerated air dryer is capable of cooling compressed air to 40F at pressure. Model F-30 consists of a ½-hp refrigerating section, a condenser-evaporator-type heat exchanger, a replaceable filter element, and an automatic discharge mechanism in an insulated pressure vessel. The dryer uses the principle of Freon-circulated closed-loop refrigeration for compressed air drying. It is rated at 30 scfm at 100 psig, 100F inlet air temperature, and 75F ambient temperature. When compressed air is dehydrated at this elevated pressure and then reduced for instrument service, atmospheric dew points of −5F are possible. Feature of the dryer is a hot gas bypass arrangement which provides continuous operation without need for cycling or on-off service. The arrangement regulates the amount of Freon that is introduced into the condenser-evaporator and permits low dew points to be maintained. **Hankison Corp.**, College & Pike, Canonsburg, Pa.

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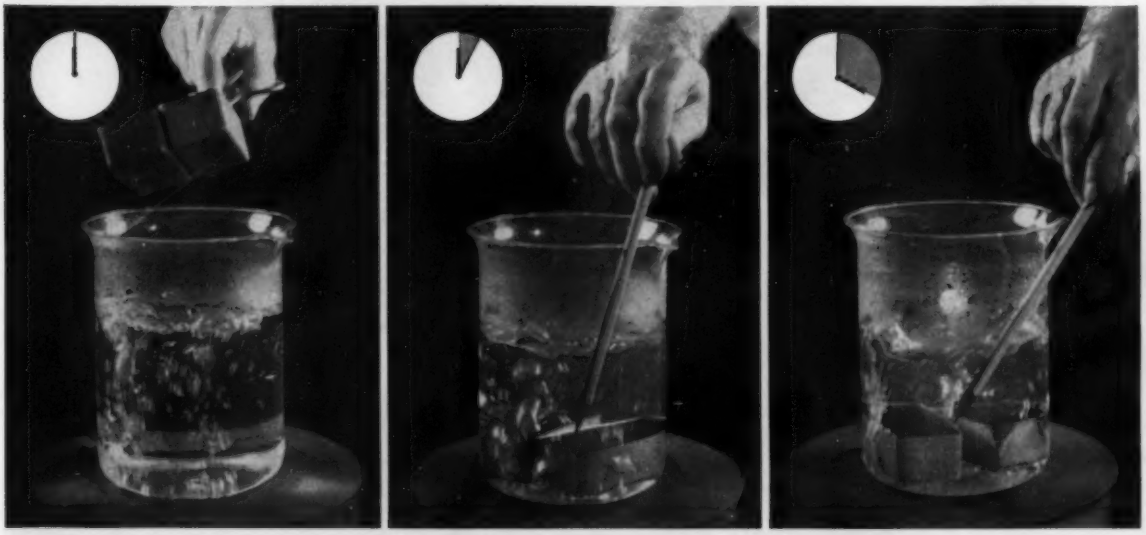
A DRAMATIC DEMONSTRATION OF THE NEW CLAD-REX 102 LAMINATE



Boiling water provides a positive test for two deep drawn* vinyl-clad parts. Neither special care in forming, nor post curing has been used to prepare either part.

Almost within a matter of seconds, the part formed of conventional vinyl-clad metal (at right) begins delaminating at the corners.

Even after as long as four hours of boiling, the part formed of new Clad-Rex 102 laminate (at left) still shows no delamination whatsoever.

New Clad-Rex vinyl-clad metal sharply reduces limitations in deep drawing and heat exposure

Has your interest in vinyl-clad metals been cooled because your product is deep drawn? . . . or because your product is exposed to elevated temperatures? . . .

Now, you can solve the problem with new Clad-Rex 102. It's a new vinyl-metal laminate that is, in effect, a single element of material. Clad-Rex 102 combines *for the first time* the ultimate properties of sheet metal with the optimum characteristics of vinyl.

Call or write for facts of this major technological breakthrough by the extensive research laboratories of Simoniz Company.

*Depth of draw equal to six times radius of corner

VINYL-METAL LAMINATES BY **CLAD-REX**® DIVISION OF SIMONIZ COMPANY

11508 W. King Street • Franklin Park, Illinois

Telephone: GLadstone 1-2323

22C

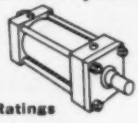
Circle 694 on Page 19

THIS ..IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer . . . piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

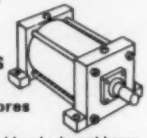
HYDRAULIC CYLINDERS



Two Pressure Ratings

2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½ to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.

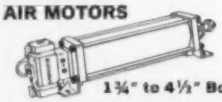
AIR CYLINDERS



1½" to 14" Bores

Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.

PARKER-HANNIFIN CORPORATION

HANNIFIN COMPANY

541 South Wolf Road • Des Plaines, Illinois

CENTRAL POINT IN THE NATION FOR FLUID POWER APPLICATION

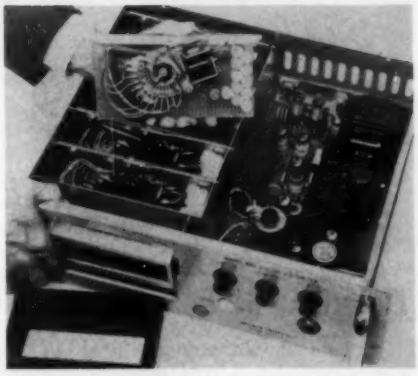
3128-PH

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.

Digital voltmeter 484 offers dc voltage measurements with printer connection and automatic print control. It is designed for applications requiring ±0.01 per cent accuracy.



All stepping switches of the 484 digital voltmeter are mounted on plug-in boards for ease of servicing. Feature of the unit is the snap-out readout for bulb replacement without tools or soldering.

Industrial Digital Voltmeter

INDUSTRIAL digital voltmeter, developed by **Non-Linear Systems Inc.**, Del Mar, Calif., offers dc voltage measurements with printer connection and automatic print control. This four-digit voltmeter is designed for applications requiring ±0.01 per cent accuracy. It is used with plug-in accessories such as input scanners and data printers, and can form the nucleus of automatic data logging systems for a wide range of applications. Output of the 484 operates an available digital data printer without modification. Provision can be made to operate most data recorders and tape and card punches. All stepping switches and decade resistors are mounted on plug-in epoxy boards. Three of the boards are interchangeable. Input connections are located on both front and back panels. Voltmeter measures dc voltage from ±0.001 to ±999.9. Addition of a dc preamplifier extends its range to ±99.99/999.9 millivolts full scale. With an ac/dc converter, the 484 measures ac voltages from 0.001 to 999.9 in ranges of 9.999/99.99/999.9 v, 30 cycles to 10 kc. It features automatic selection and indication of range and polarity, an internal standard cell for verification of calibration, simple conversion to a ratiometer, high input impedance (10 megohms), heavy-duty stepping switches and compact design. Average balancing time is one second. Power requirements are as follows: 115 v ±10 per cent, 60 cps, 50 w standby, 55 w balancing.

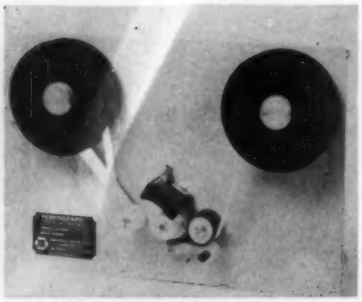
Circle 427 on Page 19

Electromagnetic Stepping Switch

ELECTROMAGNETIC stepping switch, consisting of a high speed stepping motor and printed circuit switch decks, is designed to provide true digital behavior up to 240 steps or 12 revolutions per second. Series 9C Cycloswitch has an operating life averaging 25,000,000 revolutions with light loads and adequate arc suppression. Its major component is the Sigma Cyclonome Stepping Motor. In operation, the switch will stop instantly at any predetermined position on the switch deck. The flush printed switch decks are available

in various combinations to meet specific needs. Brush arrangements can be common to 10-ring, to 20-ring, or both on one or two decks. Arrangements of three or more decks are available. Operating power for the Cycloswitch ranges from ⅓ to 40 w, depending on speed and the number of brushes. Current carrying capacity is 1.5 amps at 250 vdc. **Sigma Instruments Inc.**, 42 Pearl St., S. Braintree 85, Mass.

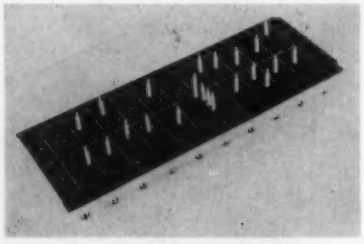
Circle 428 on Page 19



Digital Data Recorder

Designed to be used as a general-purpose, portable unit suitable for in-plant industrial information gathering, digital data recorder records information in a form visually readable and machine sensible. The recorder, designated as the Perfograph, is the heart of a complete system for machine-acquisition, storage, transmission, and reduction of data. It operates for several months on small dry-cell batteries. A series of custom input transducers measures and puts into digital form physical quantities such as rotational speed and direction, temperature, pressure, meter readings, and numerical count of items. **Advanced Instrument Corp.**, 700 S. 4th St., Richmond, Calif.

Circle 429 on Page 19



Programming Pinboard

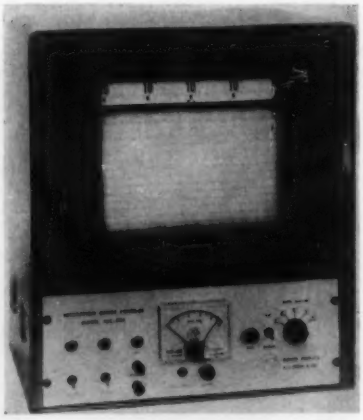
Device is essentially a memory matrix into which digital information may be manually inserted. Proper programming of the pinboard results in the production of specific output signals when certain combinations of input signals are received. The technique is applicable in the areas of code conversion, signal routing, data system programming, and tape search equipment. A pinboard consists of two contact strips (one on a vertical plane, the other on a horizontal), drilled and aligned to accept diode pins. Contact strips can be wired to a multiple plug-in connector for frequent programming changes. Templates can be placed over the pinboard to indicate proper pin placement. Programming pinboards are available in any size and configuration. Individual components such as contact strips, waffles, contact terminals, and faceplates are also available. Size of the basic pinboard is 13 by 50 columns, but the number of waffles can be increased if required. **Beckman Systems Div., Beckman Instruments Inc.**, Technical Publications Dept., 325 N. Muller Ave., Anaheim, Calif.

Circle 430 on Page 19

Electronic Scanner

Instrument can scan up to 100 inputs, utilizing a true differential, isolated, and guarded input. The measured value represents the voltage between the two input terminals, independent of the common mode voltage. Model 701 is internally organized in groups of ten channels with a maximum of 10 groups. A scanner with an internal grouping of as few as 10 channels may be later expanded to the full complement of 100. Two or more models may be operated simultaneously and interleaved to increase the effective scaning rate. Device is controlled externally by a pulse which synchronizes the scanning to other devices. This control feature permits the scanner to produce arbitrary computer format magnetic tapes up to the scanners maximum operating rate of 500 channels per second. **Electro Instruments Inc.**, 3540 Aero Court, San Diego 11, Calif.

Circle 431 on Page 19



Ionization Gage Controller

Device is designed to operate with a strip chart recorder to produce a single logarithmic chart from 10^{-3} to 10^{-9} mm Hg. Stability of the controller is less than 2 per cent drift in 24 hours. Model IGC-58 has been devised essentially for use with ionization gage tubes having a sensitivity of 100 microamperes per micron, but may be adapted to a variety of makes of ion gage tubes. Addition of the strip chart recorder coupled to the output of the controller (IGC-58R) provides for permanent, accurate, and continuous records of vacuum pressures for immediate use or future reference. **Vacuum Products Div., F. J. Cooke, Inc.**, 145 Water St., South Norwalk, Conn.

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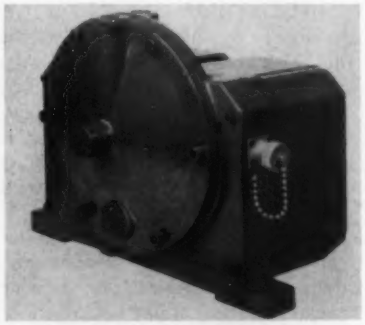

Pressure Transmitter

Designed for open hearth furnaces, soaking pits, slab heating furnaces, glass tanks, and similar applications, transmitter has a standard differential pressure range

What?

America's finest automatic transfer machines made by a light bulb manufacturer!

Many years ago we discovered that Sylvania specifications for automation equipment were so exacting, we had to make the machines ourselves. Nothing accurate enough was available anywhere, at any price.

For 20 years we have been making this automation machinery to produce our own light bulbs, radio tubes, fine electronics equipment. No one has ever equaled Sylvania automation machinery for accuracy and long-term dependability.

Now these machines are available to outside companies seeking this same extraordinary degree of accuracy.

Ideal for high-speed automatic fabricating, finishing, assembling, indexing, packaging, these machines are available in two general types:

1. Conveyor indexing chassis, exceptional for the extreme accuracy, strength, and versatility of its chain—not made commercially, but by Sylvania itself. Chassis also provides greater tool and driving capacity than other such chassis on the market.

2. Rotary indexing chassis in two sizes and in single and double turret models. Made with unusually great driving and tool capacity. Top of the transmission spider is specially machined for rotary vacuum or pressure valve.

Also, precision indexing transmissions (5 models)

- **Heavy-duty unit** with extra-large cam well and spider diameter for wider range of stops per revolution.
- **Standard unit** features higher cam speeds, a provision to integrally mount rotary vacuum or pressure valves.
- **Universal unit** operates with its output shaft horizontal or vertical. Has wide range of applications.
- **Small universal unit.** Lower silhouette and extra-long input shaft are main features of this extremely durable, accurate transmission.
- **Conveyor unit.** Very rugged, heavy-duty unit designed for conveyors, but easily adaptable for rotary tables, other intermittent motion machines.

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from −0.05 to +0.15 in. w.c. It is provided with atmospheric pressure compensation, because in the pressure range for which it is designed, the normal atmospheric pressure change over a few feet vertically can easily exceed the required accuracy of the transmitter. Accuracy of the unit is ±1 per cent of range, or ±0.002 in. w.c. It is insensitive to changes in static pressure. Output of the transmitter is a dc voltage signal in the range of 0-25 vdc. Output power can be as much as 5 w. This signal is great enough to be used directly and simultaneously by standard dc recorders and indicators, analog-to-digital converters, and electrohydraulic valve actuators. Using force-balance principles, measured pressure on the diaphragm is converted into the output voltage through an integral transistor amplifier. Simple calibration adjustments are provided. **GPE Controls Inc.**, 240 E. Ontario St., Chicago 11, Ill.

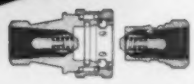
Circle 433 on Page 19

● Hydraulic and pneumatic lines are quickly and easily connected with Hansen Two-Way Shut-Off Couplings. No tools required.

When Coupling is disconnected, valves contact valve seats in both Socket and Plug to provide instant and positive seal of fluid in both ends of line. Coupling does not depend upon line pressure to seal either end of line.

Six sizes are available, with female pipe thread connections from ⅛" to 1" respectively. Furnished either in steel or brass.

Representatives in Principal Cities ... See Yellow Pages



Instantly shuts off both sides of line... prevents loss of liquid, gas or pressure.

Quick-Connective Fluid Line Couplings for

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GREASE • HYDRAULIC FLUIDS
WATER • VACUUM • STEAM
OXYGEN • ACETYLENE
REFRIGERANTS • GASOLINE
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Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

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Shaft Position Encoder

Unit will store encoder data "on the fly" at angular velocities up to 2 rps and provide an output in direct binary code. Shaft position encoder, designated TR-705 Minimodule, comprises a compact shaft position encoder and a transistorized storage circuit. Feature of the unit is its capability of storing 10 bits of data at encoder rates up to 2000 quanta per second. Output gates are provided to permit either parallel or serial interrogation. Designed to operate at maximum readout speed of 120 rpm and maximum slew speed of 1000 rpm, its accuracy is ±1 part in 1000. The encoder will maintain accuracy and meet specifications during use equivalent to that required to rotate the encoder shaft from 0 to full scale one million times. Life of the encoder is independent of the number of storage and readout cycles. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif.

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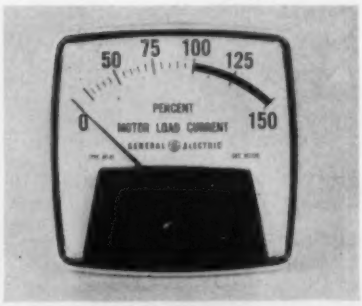
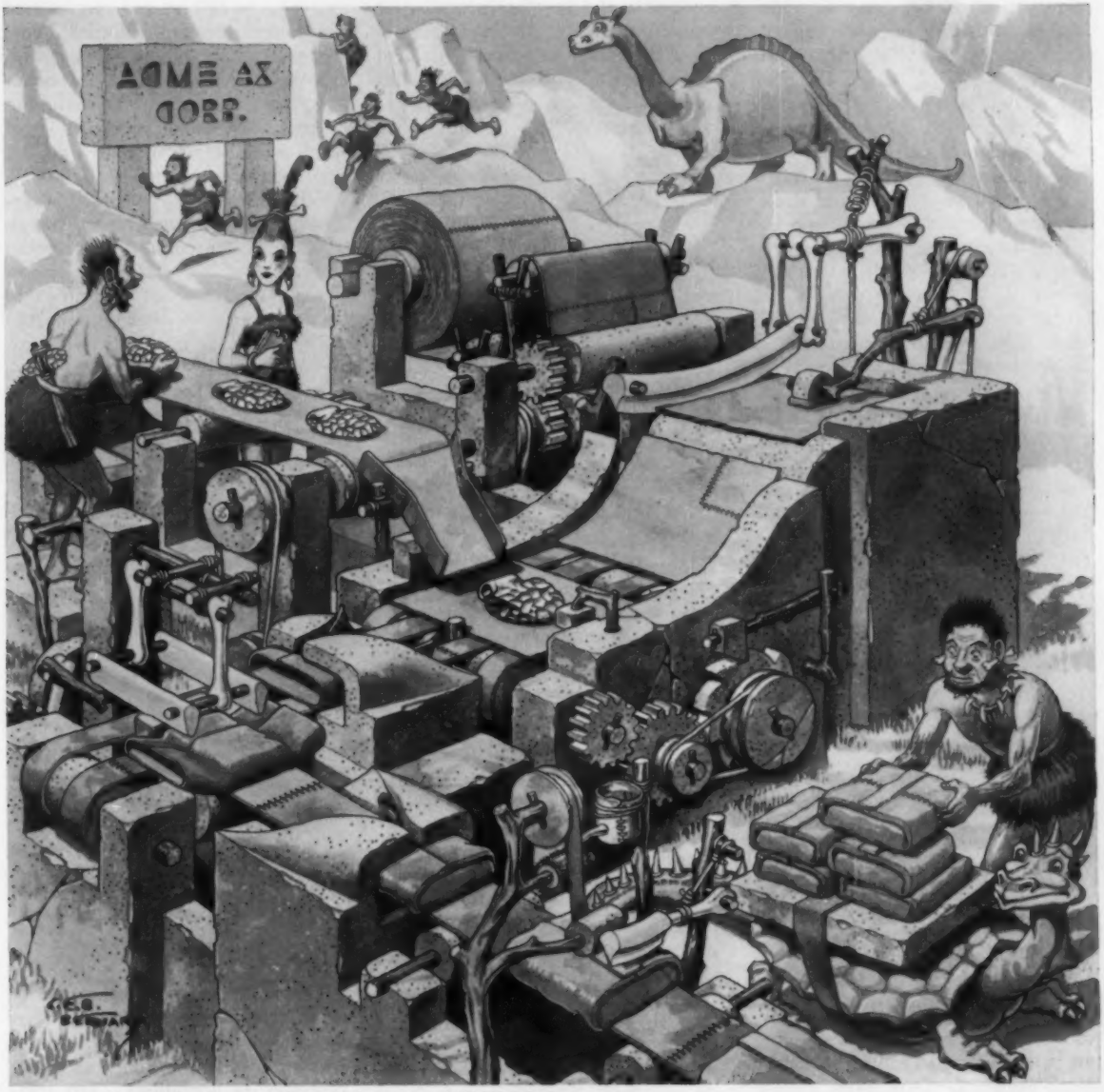


Motor Load Indicators

Line of ac and dc motor load indicators is available in three instrument sizes: The illustrated 3½-inch panel meter (two per cent ac-



The epoch-making, trend-setting, revolutionary blade wrapper of 101,116 B.C. Part of a special pictorial history of automation by Barkley & Dexter, Inc.

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This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

You should know more about B & D. Here is what our service consists of:

PLANNING — we determine if mechanization can help you; where it can help you; how it can help you; how much it is likely to cost; how much it will save.

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For further information, send for the folder on our services. Or better still, write us about your problem.

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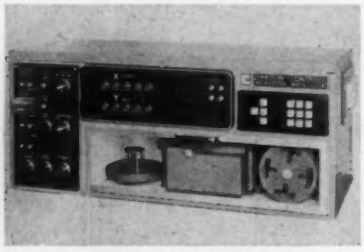
50 FRANKFORT STREET, FITCHBURG, MASSACHUSETTS—*Pioneers in Automation*

Circle 698 on Page 19

curacy), and 4¼ and 8¾-inch switchboard instruments (one per cent accuracy). Respective scale lengths are 3, 7, and 14 inches. Ac models are supplied as either ammeters, which measure per cent of motor load current; or wattmeters, measuring per cent of horsepower. The dc models are of an ammeter design and measure dc motor input current. Ac instruments are available for single and three-phase 50 or 60-cycle motors. A single ac instrument may be used with many different sized motors by employing a window-type JCH-O current transformer. Two standard scales, calibrated from 0 to 150 per cent, can be supplied. One offers a red band between the 100 and 150 per cent calibrations, and the other has a green band from 0 to 100, yellow from 100 to 125, and red from 125 to 150. **General Electric Co.**, Schenectady 5, N. Y.

Circle 435 on Page 19



Numerical Positioner

Model 600 numerical positioning control has been developed for point-to-point positioning of machine elements. Data input section of control is illustrated. All major electrical and electronic elements are of the plug-in type. Maximum traverse rate is 150 inches per minute, and power requirement is 110-120 vac, 1400 w. Transducer input can be either rack or screw, one turn equals 0.100 inch. Maximum decimal capacity is six digits per axis. Various means of data input include: Rotary decimal dials, full complement keyboard, ten key keyboard, eight channel punched tape. Standard eight-channel code is used, and control accuracy is 0.001 inch. Repeatability to 0.0002 inch is possible, depending upon application. Drive is standard ac undirectional motor with electromagnetic clutches, brake, and gear reduction unit. The servo control is of the closed loop type with final positioning always in the same direction. **Carlton Controls Corp.**, 15 Sagamore Rd., Worcester 5, Mass.

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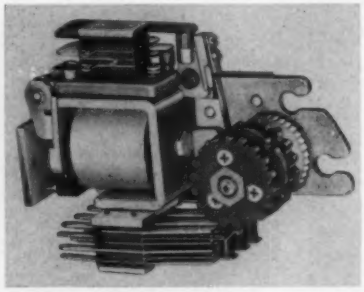

Stepping Switch

Cam-operated Model 200 stepping switch may be used as a memory device, as a replacement for interlock relays, or in applications where control of a sequence of operations is necessary. A single impulse is required to switch, and no power is required to hold it operated. Switch is available in models with up to eight cams providing 30, 32, or 36-tooth ratchets. Its operating speed is up to 60 sps self-interrupted or 30 sps remote-impulsed. A wide variety of dust cover and hermetically sealed enclosures are available. Enclosures can be sealed in oil. **C. P. Clare & Co.**, 3101 Pratt Blvd., Chicago 11, Ill.

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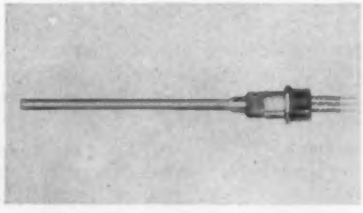

Temperature Detector

Device, capable of measuring temperatures as high as 1500 F, is available for general industrial use. Model 242P resistance temperature detector is hermetically sealed in its own well for use under pressures up to 300 psi and can be used in any standard ⅜-inch bore thermowell for higher pressures for the measurement of highly corrosive liquids or gases. Detector has a resistance tolerance of ±½ per cent of resistance at 32 F and ±1 per cent of resistance above 600 F, offering increased accuracy when used with indicators, recorders, or controllers. Because the change in resistance of the detector is almost directly proportional to change in temperature, the detector will read temperature differentials with extreme accuracy. **Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co.**, West Orange, N. J.

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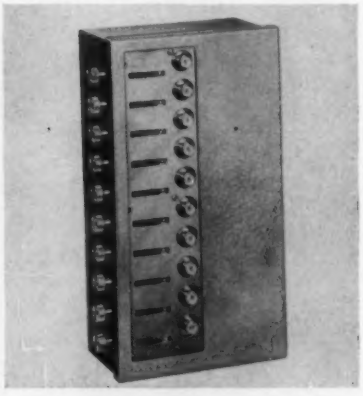


Time Utilization Panel

Device is designed, by means of pilot lights and time accumulation figures, to show the productive operations of ten individual machines, processes, or operations. Ten individual running-time meters (each with its own signal light) comprise the panel. The machines or operations to be monitored can be located at distances up to 5000 feet. Meters can be read to the nearest hour and tenth; or hour, tenth, and hundredth; or minutes and tenths. They can be connected to show productive machine time, idle or lost time, or down-for-service time. In plants they are used to show production time and hours of machine use. In offices they are used to determine wages, bonus, schedules, and incentives. They can also be used to indicate exact time on leased machines and for accumulating data for preventive maintenance and

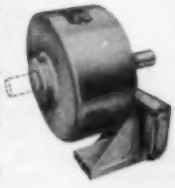
Reuland motor-and-magnetic-brake package

...complete from one dependable source!

Reuland manufactures its own magnetic brakes, as well as electric motors, and offers the most versatile selection of tailored-to-your-equipment *brakemotor* packages available anywhere. Reuland's many hundreds of combinations of H.P., speed, special drive motors and brake sizes, provide an almost unlimited coverage of O.E.M. and user requirements!

So, whatever your *brakemotor* needs may be, standard or special, let Reuland supply the complete answer in one, compact, smartly-designed power package. One source of supply for brake and motor saves time for your Engineering and Purchasing Departments... one nameplate establishes dependable, nationwide service responsibility!

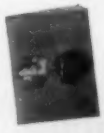
Refer to Sweet's Product Design, Section 5-a



BRAKES AVAILABLE IN ALL 3 MOUNTINGS... FULFILLS J.I.C. SPECIFICATIONS!

1. Direct endbell type for mounting over motor's shaft.
2. Foot mounted, for mounting over existing shaft.
3. Foot mounted—complete with own bearings and shaft.

- Automatic Lining Wear Adjustment
- Manual Release—Automatic Reset
- Mount in any position
- No Levers or Linkage
- One-Piece Housing
- One-Half Conventional Length
- Wide Range of Ratings



Our new 8-page catalog, No. GS8-30-0, will come in handy. Sent complete with prices and engineering drawings on request.

MODERN POWER FOR MODERN-DAY PRODUCTS

...all in lightweight, cool-running aluminum frames!

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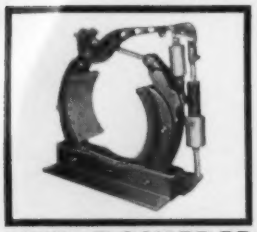
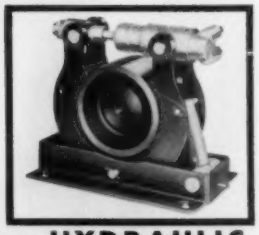
Distributors in all principal cities

Circle 699 on Page 19

STOP EQUIPMENT SAFELY

with Wagner





AIR POWERED or HYDRAULIC BRAKE SYSTEMS

Wagner makes both air powered and hydraulic industrial braking systems that stop your equipment safely, easily, economically.

WAGNER AIR POWERED BRAKING SYSTEMS use the same heavy-duty brakes that Wagner builds for hydraulically operated overhead crane brakes. Application is flexible . . . any number of brakes and control points may be used at reasonable distances from each other.

WAGNER HYDRAULIC BRAKE SYSTEMS let you put the *right* braking system on your large or small cranes. Example: new 6" x 3" size brakes are perfect for floor-operated or small cab-operated cranes.

Let your nearby Wagner Sales Engineer help you select the braking system best suited to your needs. Call him today.

W160-4

Wagner Electric Corporation

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Circle 700 on Page 19

POST MEASURING SYSTEMS

Connected to any Post Decitron electronic counter, the new lineal footage device permits accurate length measurement for continuous production items.

Each time the wheel revolves, a photolight beam is broken and a count equal to one foot is registered by the counter. Varied "beam-hole", or wheel size will permit the counting of fractional parts of a lineal foot if desired. Different types of wheels provide traction surfaces for wire, rope, aluminum sheets, bar or flat steel, paper, cloth.

Used in conjunction with a Post Decitron "Preset" counter, (i.e. PW-2) a predetermined length of stock can be measured, and "marked" or cut-off as desired.

Ideal for labels and paper making where footage is most accurate measure of production.

Decitron

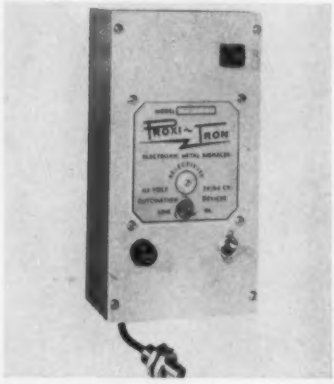
POST ELECTRONIC PRODUCTS

Division of Reid Brothers Company, Inc.

12 LOTHROP ST. / BEVERLY, MASS.

cost statistics. Maximum load capacity is 65 w. Lamps for 26 v are filament type; others are neon. Motor drive is 26 v, 115 or 200 v. Typically, panel operates on 60 cycles ac current. The six digit figures provide for reading totals at any time. All read-out totals are resettable to zero. **Gorrell & Gorrell**, 336 Old Hook Rd., Westwood, N. J.

Circle 439 on Page 19



Metal Detector

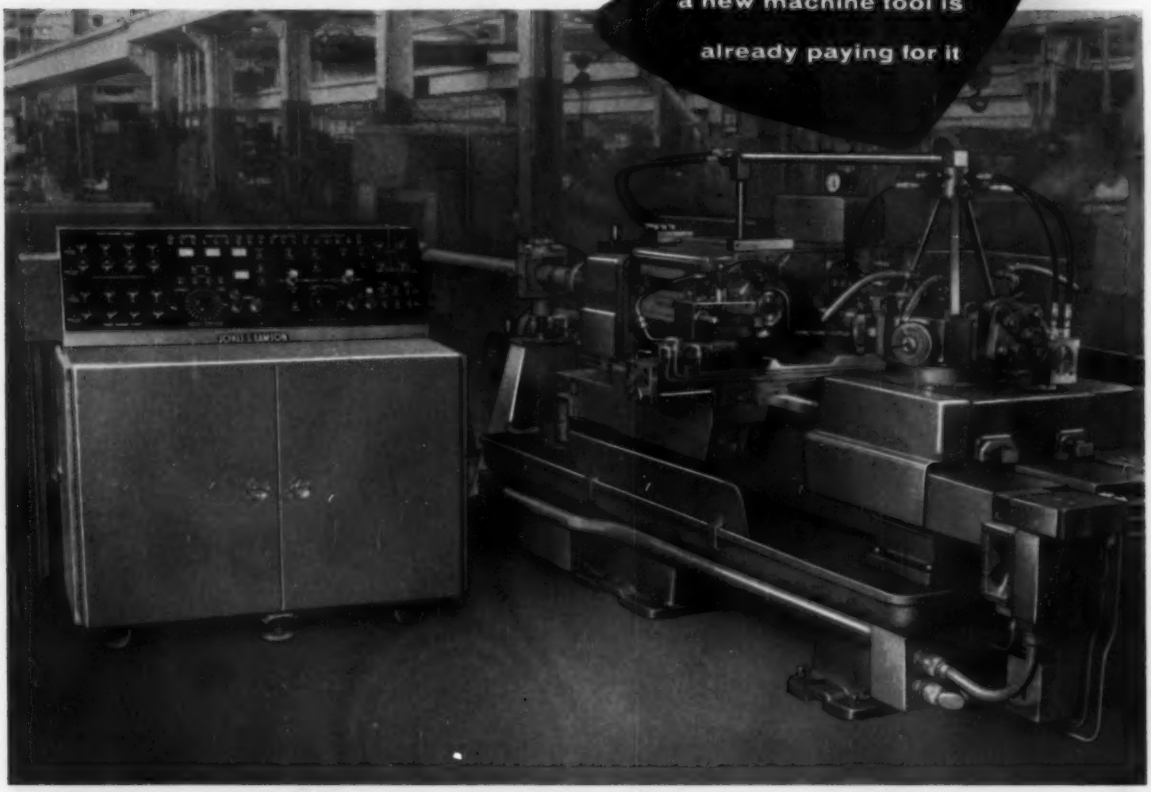
Proximity switch, designated Proxi-Tron, is designed to detect any type of metal without physical contact. Device can be used as a machine tool limit switch, to detect metal inside nonmetallic containers, for solenoid operation, metallic/nonmetallic differentiation, counting, batching, broken tool detection, multiple operation machine co-ordination, and conveyor and feeder control. Unit is completely transistorized, and electrical components are sealed against moisture and dust hazards. They are unaffected by temperature changes or normal voltage fluctuations. Operation is immediate. Neon lamp indicates pickup signal. Detector is supplied with standard ½-inch male probe and 5 feet of shield cable. The probe head can be immersed in liquids. Standard relay is 2 amps, and capacity is up to 1000 operations per minute. Higher capacities are available for high speed applications in which case a ballast replaces plug-in type relay, providing electrical signals up to 100,000 operations per minute. **Automation Devices**, Erie, Pa.

Circle 440 on Page 19

Circle 701 on Page 19

JONES & LAMSON "AUTOMATION"

the man who needs a new machine tool is already paying for it



New numerically-controlled turret lathe shatters idle time . . . is ideal for short runs

At the last Machine Tool Exposition, five years ago, Jones & Lamson exhibited an automatic tape-controlled turret lathe. It created a sensation and attracted thousands of fascinated spectators. Many of them wanted to buy. But the machine wasn't for sale. Why? Because there were still "bugs" in it to be ironed out, and our reputation is too valuable to risk on an "almost" product.

In the five years since, J & L still kept this lathe off the market, pending its complete development and proving-out. Now, it is ready to be shown, ready to be sold, ready to help you attain new production efficiency.

The new J & L numerically-controlled turret lathe is a complete redesign job. The sound features of the early prototype have been retained, and all question marks have been eliminated. In every way, this is a real beauty!

It's designed especially for short run production and top economy. It has the capacity of a No. 5 machine, 2½ x 24 in., and has three turrets (one hexagon and two square) which accept up to 14 preset tools. A set of tools plus the tape can be "packaged", ready for set-up when needed.

This lathe can be set up as either a bar machine or a chucker, in 10 to 15 min. It positions within .001″, repeats to .0005″. Drive motor is 30 HP, with spindle speeds of 40 to 2000 rpm in 24 steps. Feed rates for carriage and saddle are .750″ to 30.0″ per minute in 16 steps, plus fast motion. Cross-slide operates at one-half these rates. Tape input information may be adjusted for extended tool life and size control by manual dials on the control panel. Productivity is increased 25 to 30% over standard cycle time. Even the automatic bar feed is programmed from the tape. See it at Chicago, or write for advance information now. Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 702 on Page 19

New! ...from Waterman

MAJOR BREAKTHROUGH IN HYDRAULIC VALVE DESIGN!

Series 1617-A A.C. 4-Way Solenoid Valves

- No inrush current
- Very fast cycling permissible
- No dynamic seals—packless
- High capacity—low pressure drop
- Compact—light in weight
- For pressures to 3000 p.s.i.
- Rock-bottom cost
- No coil burn-out if valve sticks

Designed for simplified stacking or banking

Here it is—the new pace-setter in A.C. solenoid valves! Exclusive Waterman design has eliminated inrush current, making possible fast cycling (in excess of 250 per minute) without overheating. Standard coils suitable for 25 to 60-cycle current. Weight of ¾" size is less than 6 lbs., including two solenoids. Closed-center, tandem, and two-position types available. Rated 3000 p.s.i. pressure may be applied to all ports. Working parts totally immersed in hydraulic fluid. No moving seals—packless. Screw-type electrical terminals in steel housing. Also furnished for D.C. operation.

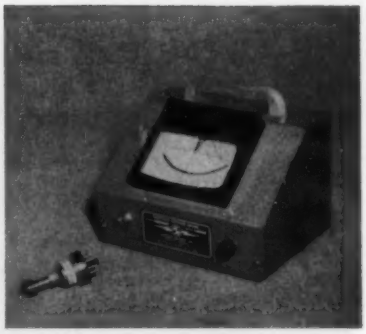
SEND TODAY FOR YOUR COPY OF NEW CATALOG 2002

Also suppliers of AN and MS qualified flow regulators and fuses, including flow regulators for fuels and cryogenic fluids

WATERMAN HYDRAULICS CORPORATION

W-2002

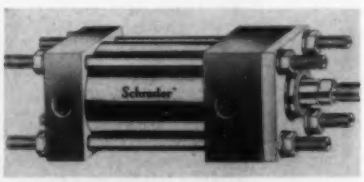
WATERMAN HYDRAULICS CORPORATION • 725 Custer Avenue, Evanston, Illinois



Vacuum Controller

Device can control and ensure safe operation of vacuum equipment. It is ideal for control of diffusion pumps, operation of solenoid valves, automatic charging systems, and maintaining preset pressures by automatic start and stop of vacuum pump. Featuring continuous reading throughout the entire range, and automatic reset of the control relay, controller is available in four ranges from 0.2 micron Hg through 200 mm Hg absolute. The control pointer may be set at any pressure desired within the control range on the direct reading scale. Control sensitivity is within one per cent of the setting. Model VC-5 covers the range of 0-100 micron Hg; Model VC-3, the range of 0-1000 micron Hg; Model VC-4, 0-20 mm Hg, and Model VC-2, 10-200 mm Hg. Instrument operates from 90-135 v 60 cycle ac and is available in cabinet, panel, and rack panel mountings. Matched, interchangeable gage tubes are available which are unaffected by exposure to the atmosphere or by atmospheric pressure changes. **Hastings-Raydist Inc.**, Dept. 10, Hampton, Va.

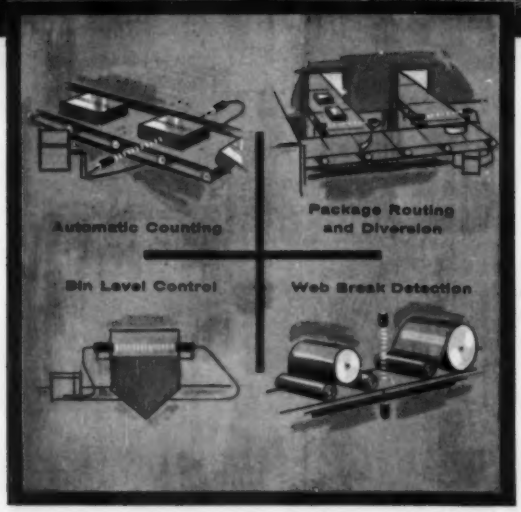
Circle 441 on Page 19



Cylinder Mounting

Mounting has been designed for use on a line of square end double-acting air cylinders. Cylinders are rated for air pressures up to 250

a new dimension in automated controls



SONAC ULTRASONIC,

NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration, dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assemblies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on request.

DELAVAN
Manufacturing Company
WEST DES MOINES • IOWA

Circle 704 on Page 19

NEW WESTINGHOUSE PROXIMITY LIMIT SWITCHES

...OUTLAST MACHINES THEY CONTROL

Why? They won't wear out. No tubes . . . no moving parts . . . no contacts to spark, pit or wear. They're corrosion resistant . . . sneer at dust, dirt or oil mist . . . could operate under water. They've passed military shock and vibration tests . . . fit most applications. Two sizes of sensing heads available for tripping distances within ½ inch or within 2 inches.

Cost? Westinghouse proximity limit switches cost a little more—but pay for themselves over and over again because they banish expensive machine down time for switch service and replacement.

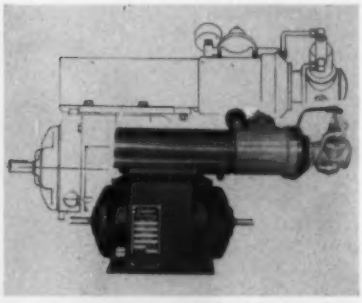
CALL TODAY for the facts on the new Westinghouse proximity limit switches. Your nearest Westinghouse sales engineer will show you how they can save you time and money. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-25002

YOU CAN BE SURE...IF IT'S Westinghouse

psi and hydraulic pressures up to 750 psi. Mounts include angle bracket, side leg, and extended tie rod (shown). The choice of mounting available makes the cylinders adaptable for a wide range of holding, positioning, or moving work. The mounts are intended to handle specific situations. The angle bracket mounts can be repositioned to tie rods on any side of the cylinder, allowing parts to receive piping conveniently from any direction. Side leg mounts are ideal for strong, rigid, inline mounting, or for tight, lengthwise spaces. Extended tie rod mounts provide versatile mountings for front, back, or both ends in straight-line locations. Unwanted rod extensions can be cut off. **A. Schrader's Son, Div. Scovill Mfg. Co.,** Brooklyn, N. Y.

Circle 442 on Page 19



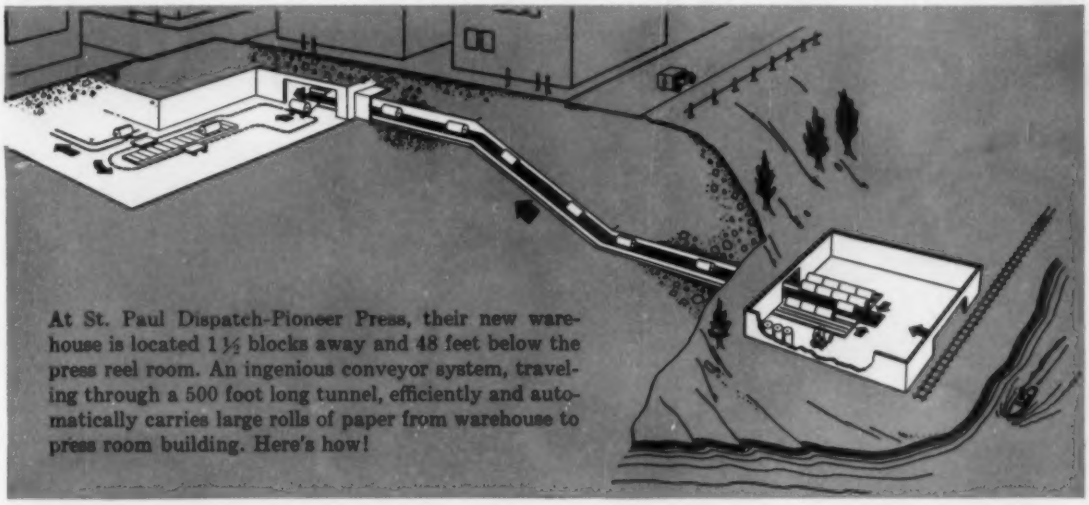
Variable Speed Drive

Feature of this unit is pneumatic control which provides remote or automatic speed control over an infinite range. Transmission is applicable to precise feed or metering control and for use in automatic speed control systems. Air signals, varying from 3 to 15 psi, produce linear speed variation from any desired maximum speed to zero. Speed may be set by manual air valve or automatically by a signal generated by a variety of pneumatic transducers. Movement of the control cam causes axial movement of a control ring which engages three tapered rollers supported in a carrier joined to the motor shaft. Pinions fixed to the large end of the rollers engage a ring gear carried by the output shaft. Contact pressures between the rollers and the traction ring are developed centrifugally, thereby permitting speed change with the transmission running or

Circle 705 on Page 19

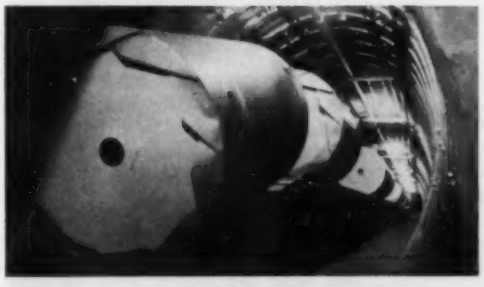
Circle 706 on Page 19→

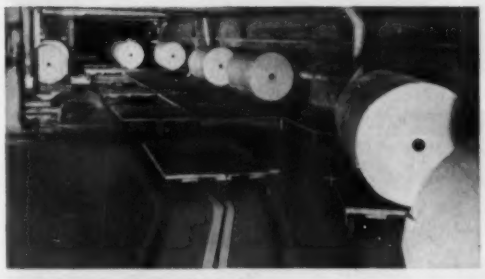
This Webb automatic conveyor system hustles newsprint thru 500 foot tunnel



At St. Paul Dispatch-Pioneer Press, their new warehouse is located 1½ blocks away and 48 feet below the press reel room. An ingenious conveyor system, traveling through a 500 foot long tunnel, efficiently and automatically carries large rolls of paper from warehouse to press room building. Here's how!

ROLLS REALLY KEEP ROLLING





1. At warehouse, the newsprint rolls (60" long x 36" in diameter and weighing 1500 lbs.) are removed from railroad cars by lift trucks and stacked for storage or placed on the tunnel conveyor for current use. Systematic loading of conveyor is accomplished by two sets of kicker plates which operate in series to propel four rolls at a time into spaced positions on the conveyor. Kicker plates are actuated by bumper switches and air pressure.

2. Tunnel conveyor is divided into four individually powered sections which can be operated "continuous-run" or separately for programming. The ascending section is built on a 15-degree incline and its slats are rubber coated to preclude slipping of load. A continuous live-supply of rolls (spaced 18 inches apart) is maintained by means of electric eye controls at beginning and end of each section.

3. When rolls reach the press room basement, they are automatically pushed off the tunnel conveyor and onto Towveyor trucks. Thirty-one of these trucks are attached to a moving chain loop in the floor to provide additional live-storage of rolls. In the reel room area, a semi-automatic "kick-off" pushes the rolls from the Towveyor trucks onto press room trucks as needed.

System capacity is 130 rolls, manual handling is eliminated, live and stationary storage is provided, and high efficiency is assured by the soundly engineered solution of this unusual material handling problem.

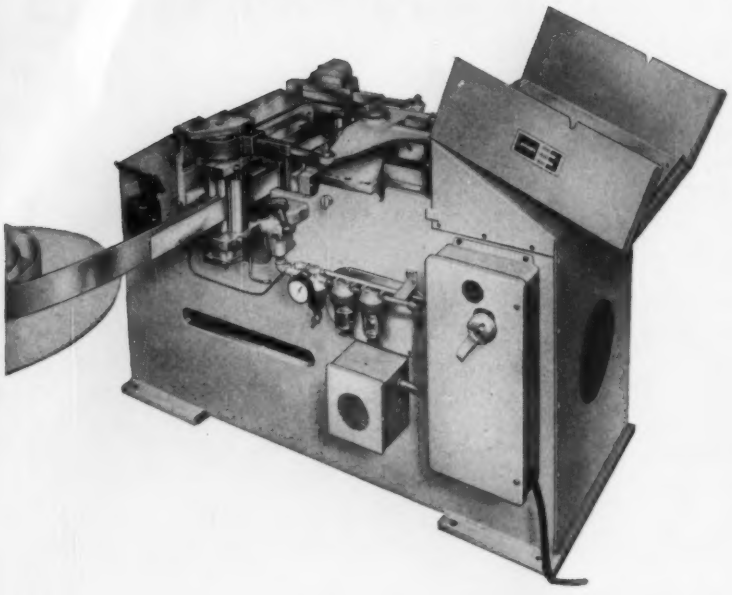
WEBB

JERVIS B. WEBB COMPANY

8945 ALPINE AVENUE • DETROIT 4, MICHIGAN

SPECIALISTS IN CUSTOM CONVEYOR SYSTEMS

so fast...



...you may not believe it!

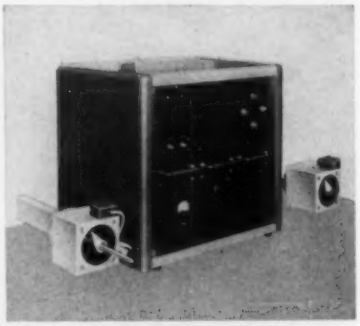
At 1500 strokes a minute — maybe better — this new Emhart press zips open a fresh, exciting page in metal fabrication. And in non-metallic fabricating, as well. We have the feed to go with this super-speed, too, plus the experience to help you realize the full potential of this press. The dramatic — and believable — details are yours for the asking.
EMHART MANUFACTURING COMPANY,
HUDSON DIVISION, HUDSON, N. Y.

EMHART

Circle 707 on Page 19

stationary. Transmission is available with several styles of built-in reducers and with a variety of motors including explosion proof. **Graham Transmissions Inc.**, Menomonee Falls, Wis.

Circle 443 on Page 19



Step Motor System

High-speed bidirectional syncro-pulse step motors provide mechanical motion, positioning actuation, or digital-to-analog conversion as an exact function of pulse signals, and without feedback circuitry, clutches, or brakes. Two hundred steps per revolution provide high resolution and linear accuracy. Unit is normally furnished with a combination dc power supply and solid-state, completely transistorized control circuit which has separate inputs for *Forward* and *Reverse* pulse signals. The control system input circuits will accept sine wave, square wave, or triggered pulses as low as six v peak. The syncro-pulse step motors provide positive starting, stepping, and stopping response at pulse freqencies up to 300 pulses per second, and will operate at 4000 pulses per second with minimum acceleration and deceleration of pulse signal source. The available torque permits positive response up to 100 steps per second with 80 inch ounce applied load and up to 200 steps per second with 40 inch ounce applied load. Device is available with either rotary output shaft or with nonrotating coaxial lead screw. Optional accessories include a variable frequency pulse generator and/or manual preset counter. **Farnham Electronics Div., Wiesner-Rapp Co. Inc.**, 1600 Seneca St., Buffalo 10, N. Y.

Circle 444 on Page 19

Touch a button—tighten many nuts at once to precision torque

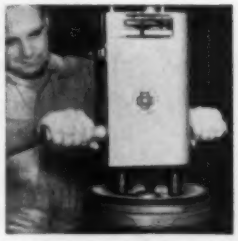
This auto manufacturer tightened down on production costs by automating wheel-nut running. All five are tightened at once with a Gardner-Denver multiple nut setter.

These versatile tools are highly adaptable to a wide variety of time-consuming production jobs. At the touch of a button, nuts of different size, angle or elevation are tightened to precise torque. Tighten two, three, five, twenty or more.

MODEL CHANGE

Standardized components make switching from job to job quick and easy. When bolt pattern changes, simply move the standard spindle and handles to a new, job-tailored mounting plate. And Gardner-Denver can also engineer one of its new, adjustable multiple nut setters for you. Here, when your production run includes several similar bolt patterns, you merely push a button to reposition the tool. No change in mounting plate is required.

Find out how Gardner-Denver nut setters, along with a complete line of other production-speeding air tools, may solve tough problems for you . . . lower unit costs. Contact your Gardner-Denver air tool specialist or write for new Bulletin 16-101.



Tighten entire nut clusters in one operation with Gardner-Denver multiple nut setters. Write for further information.

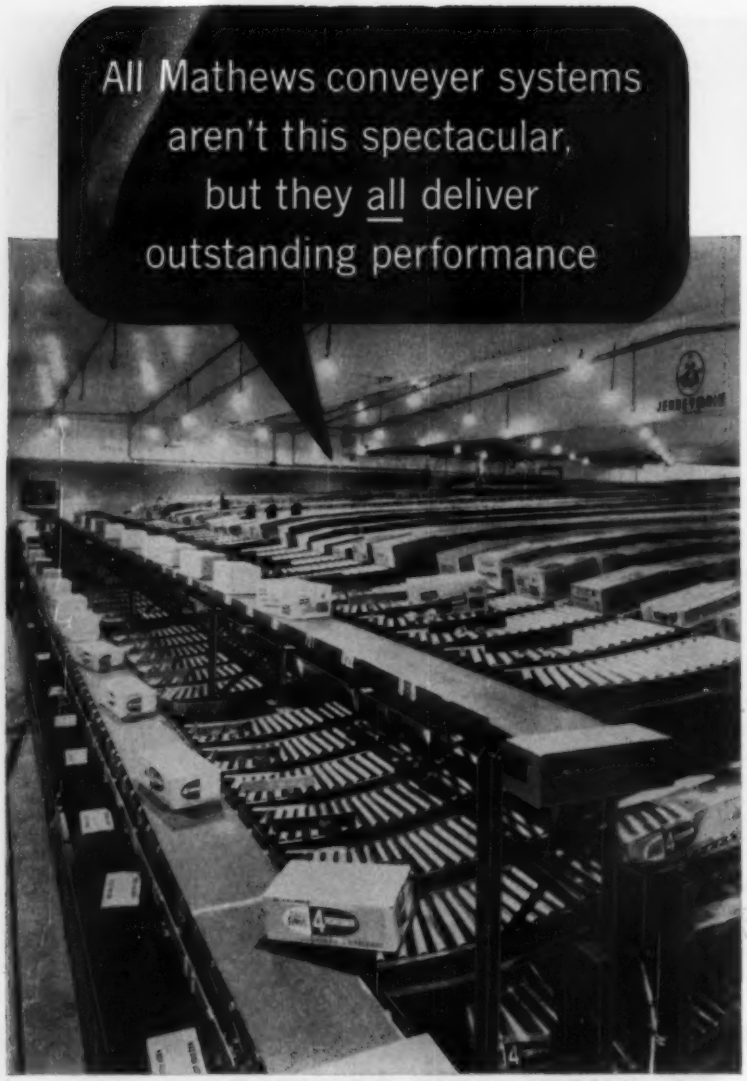
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Circle 708 on Page 19



• It's true that everyone can't use an order-selecting system like this — but — it's also true that everyone specifying conveying equipment has a right to expect this type of *outstanding performance.*

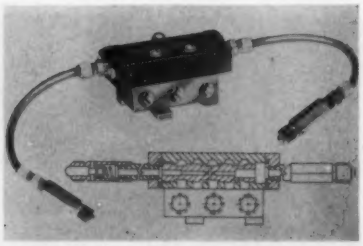
You can have the benefit of well-planned mechanized handling in *your* plant. Mathews Engineers would like to work with you in developing a conveying system that will create a smooth flow of *your* product — a system that will deliver outstanding performance *for you.*

GENERAL OFFICES ..... MATHEWS CONVEYER COMPANY
Ellwood City, Pennsylvania
WESTERN DIVISION ..... MATHEWS CONVEYER COMPANY WEST COAST
San Carlos, California
CANADIAN DIVISION ..... MATHEWS CONVEYER COMPANY, LTD.
Port Hope, Ontario, Canada

Over fifty Years of Leadership in Mechanized Handling

MATHEWS

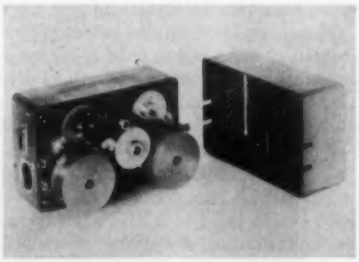
Circle 709 on Page 19



Air Valve

Pilot-operated four-way air valve is ideally suited for sequencing, and remote control applications. It can be used for a variety of operations under bleeder operator control. Capable of over 1000 cycles per minute, this five-ported valve has a life expectancy exceeding 50,000,000 cycles. Small bleeder operators featuring a hardened ball nose plunger can be mounted anywhere. In some circuit applications, the valve can be used as a two-way normally-closed valve. Operating principle is as follows: Line pressure is admitted to both ends of the spool through the drilled core. Since the areas at both ends are equal, the resultant thrusts are balanced. Bleeding the air from either chamber, by means of a bleeder operator, upsets the balance, causing the spool to shift toward the bled, or lower pressure end. The valve will operate at less than 5 psi line pressure, and is available as a double-bleeder for momentary operation, as illustrated, or as a single-bleeder for maintained operation. **Alkon Products Corp.**, 200 Central Ave., Hawthorne, N. J.

Circle 445 on Page 19

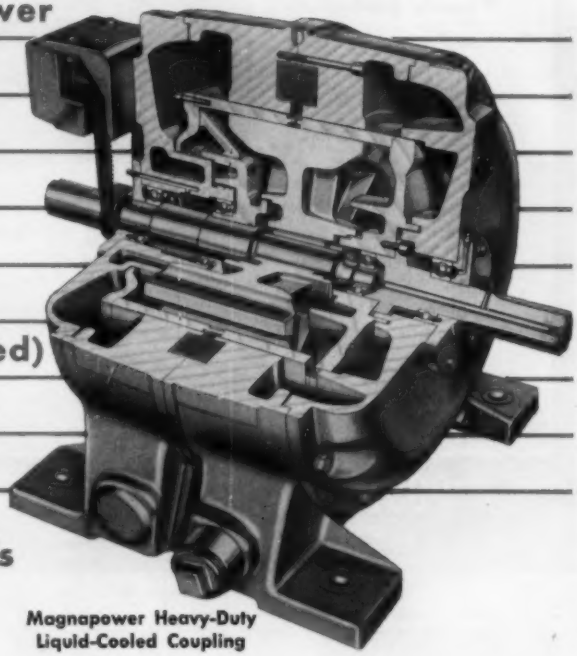


Tape Programmer

Model TP-860 is an 8-channel, punched tape programmer using standard 1-inch wide punched tape. It has a forward drive and auto-

10 good reasons for choosing Dynamatic Eddy-Current Speed Control Equipment

1 Adjustable speed from AC power
2 Accurate speed control
3 Wide speed range
4 Rapid response
5 Low power loss
6 Simplified construction
7 Remote control (when desired)
8 Quiet, efficient operation
9 Low maintenance cost
10 No commutators, rings, brushes, or rotating coils



Magnapower Heavy-Duty Liquid-Cooled Coupling

Using standard alternating current as a power source, Dynamatic Eddy-Current Couplings and Drives are the answer to practically all stepless adjustable speed requirements.

A wide range of standard and special control features may be obtained from electronic or transistorized magnetic amplifier control systems. The addition of an eddy-current brake to standard couplings or drives provides smooth, cushioned stops and controlled deceleration.

Dynamatic Eddy-Current Equipment is available in sizes from ¼ hp Ajusto-Spede Drives to heavy-duty Magnapower Couplings rated up to 20,000 hp—and larger.

Place your speed control problems in the hands of experts. Our representatives, located in all principal cities, are fully qualified to discuss your speed control problems and suggest Dynamatic Equipment that will do the best job for you. Call Dynamatic today—there is no obligation.

EATON

DYNAMATIC®

ORIGINATOR AND LEADING PRODUCER OF EDDY-CURRENT SPEED CONTROL EQUIPMENT

May we Send You Illustrated Literature Describing Dynamatic Eddy-Current Equipment

EATON DYNAMATIC DIVISION MANUFACTURING COMPANY
3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 710 on Page 19

POST ELECTRONIC PRODUCTS

Keeps tabs on hourly production *and* count . . . too!

MODEL P2 RM

The Post P2 RM is a preset electronic counter which **also indicates hourly production rate** on a two-scale rate meter. By using this dependable component in conjunction with sheet fed machines, conveyor lines, small parts manufacturing, etc., you have the benefit of "batch" counting desired quantities. At the same time you'll be able to keep tabs on your production flow. A visual totalizer indicates unit or total batch counts.

For complete details write: Decitron

POST ELECTRONIC PRODUCTS

Division of Reid Brothers Company, Inc.

12 LOTHROP ST. / BEVERLY, MASS.

Circle 711 on Page 19

ACRO WELDER MFG. CO.

MILWAUKEE

WELDING ENGINEERS

MACHINERY BUILDERS

ESTABLISHED 1936

ACRO® general purpose spot-projection-butt-seam resistance welding machines.

ACRO-ARC® special purpose production welding machinery employing automatic arc welding processes.

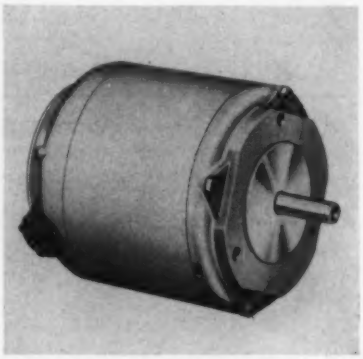
ACROMATIC® special purpose production welding machinery employing resistance welding processes.

ACRO-MAGNETIC® magnetic force spot, projection, and percussion welding machines.

Circle 712 on Page 19

matic rewind with separate motors for each operation. Contacts are insulated from each other and make contact to a common drum where holes are punched in the tape. The tape is sprocket-driven at a constant speed between the contacts and the drum. Standard tape speed is 1 inch per second. Programs can be controlled in 0.1-second increments from zero time through the full length of the tape stored. Tape capacity is 100 feet of 0.002-inch-thick tape. Unit will operate on 115 v, 60 cycles, single phase. **Anaheim Electronics Div., Electronic Engineering Co. of California,** 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 446 on Page 19



Synchronous Motor

Permanent magnet type synchronous motor is designed primarily for heavier duty industrial use. It can provide ac synchronous speed or dc stepping, and is adaptable for service as a prime mover for controlling valves, heat devices, and machine tool carriages. A single-pole, three position switch is used to control operations. When motor is used as an incremental positioning device, dc voltage applied to the field windings converts one revolution of the motor shaft into 200 precise steps. Slo-Syn Model SS250 ratings are: Input 120 v, 40/70 cycles, 1 phase, 0.6 ampere maximum current (at 60 cycles); 72 rpm output speed at 60 cycles; 250 ounce-inches torque. Planetary gear Model SS250-Pl is available for applications requiring a torque of 650 ounce-inches and a speed of 16.6 rpm. **Superior Electric Co.,** Dept. SS, Bristol, Conn.

Circle 447 on Page 19

NEW

CAGEROL®

CAGE TYPE
HEAVY DUTY
NEEDLE ROLLER
BEARING

BY McGILL®

INCREASE EXPECTED LIFE UP TO 10 TIMES!

You need CAGEROL bearing performance if higher speeds and increased misalignment have prevented the utilization of needle bearing load capacity in your applications. Most important, CAGEROL bearings can deliver up to 10 times more expected life where misalignment and increased speeds exceed the capabilities of ordinary and guided needle bearings. The difference is in the exclusive McGill construction that features tapered retainer pockets for balanced roller guidance, crowned rollers, and black oxide retainer finish. CAGEROL bearings are interchangeable with all heavy duty needle roller bearings — with or without inners in two bore sizes.

McGILL MANUFACTURING CO., INC., Bearing Division
401 N. Lafayette Street, Valparaiso, Indiana

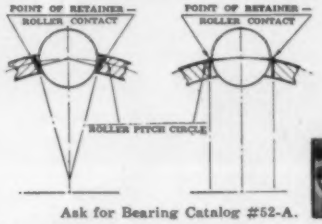
1 Exclusive crowned roller construction, electronically gauged to insure precision contour and size uniformity. Relieved ends assure even load distribution.

2 Flat ends fully engage integral race shoulders, provide maximum support.

3 Proper guidance assured by tapered retainer pockets. The design insures *balanced* roller support and eliminates corner wear from edge loading of straight pockets where retainer OD and pitch circle are coincident.

4 Simultaneously punched pockets assure accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication, reducing the friction coefficient.

5 SAE 52100 steel outer race has optimum hardness and surface finish.



Ask for Bearing Catalog #52-A.

engineered electrical products

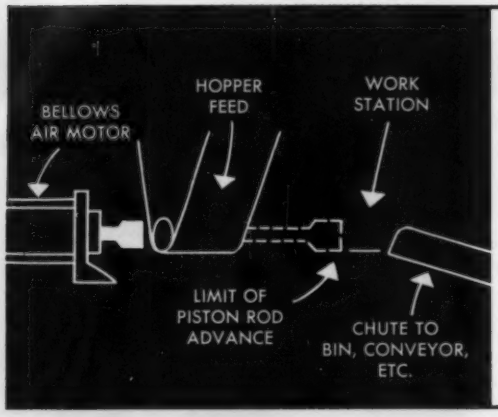
McGILL®

precision needle roller bearings

Circle 713 on Page 19

ONE OF THESE INEXPENSIVE, SHOP-BUILT WORKFEEDERS CAN SAVE YOU HUNDREDS OF DOLLARS

Shown here are three ways you can use Bellows Air Motors® to feed and position workpieces more quickly, efficiently and at lower cost. They are typical of the many ways Bellows Air Motors are used in all types of industries.

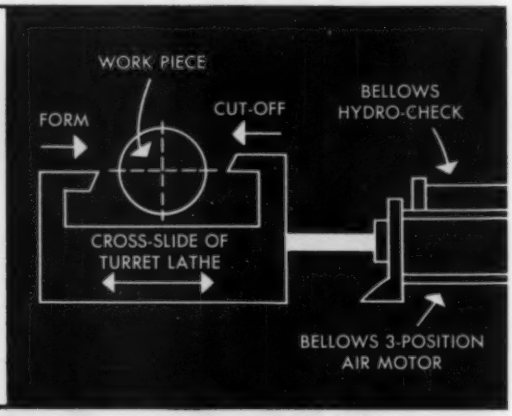


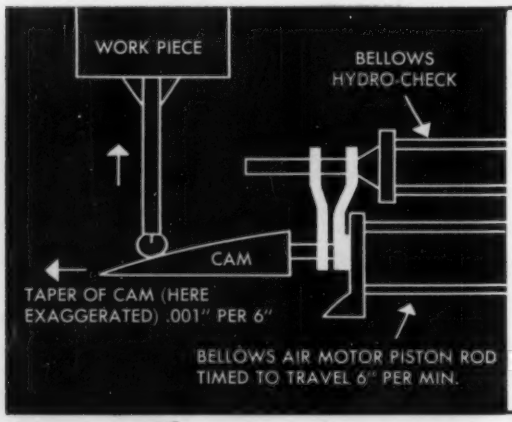
HORIZONTAL, STRAIGHT-LINE POSITIONING AND EJECTING

This extremely simple set-up is widely used in conjunction with hopper feeds in stamping and coining, sawing, drilling, deburring, inspection and similar operations. On its advance stroke, the piston rod of The Bellows Air Motor takes a workpiece from the hopper and moves it until, at full advance, the piece is properly positioned for the operation. The positioning of each workpiece serves to eject the preceding unit. Speed of advance and retract strokes is individually adjustable. The Air Motor can be set for either single cycle or continuous operation, and, when desired, is easily synchronized with a machine element.

FEEDING CROSS-SLIDE OF TURRET LATHE

The sketch at right shows a typical application of a Bellows 3-position Air Motor feeding the cross-slide of a turret lathe. Center, or "neutral," position of Air Motor piston rod is tool "at rest" position. Rod retracts to "form," advances to "cut-off." Using sequencing switches, the Air Motor's operation can be synchronized with the automatic turret to "form" at any point in turret's sequence, return to neutral until all other operations have been performed, then to advance to "cut-off." Speed of advance and retract strokes is independently adjustable. Incorporation of a Bellows Hydro-Check® provides accurate control of piston rod, complete freedom from "chatter."




WORK PIECE
BELLOWS HYDRO-CHECK
CAM
TAPER OF CAM (HERE EXAGGERATED) .001" PER 6"
BELLOWS AIR MOTOR PISTON ROD TIMED TO TRAVEL 6" PER MIN.

SLOW, ACCURATE FEED RATE

Slow and/or highly accurate feed rates—such as might be required by certain grinding and cut-off operations—can be achieved by advancing the work-holding fixture by the action of a roller moving on a tapered cam which is mounted on an Air Motor's piston rod. As shown in the sketch at left, for example, the cam has a taper (greatly exaggerated in the illustration) of .001" per 6" length. If the piston rod is timed to travel 6" per minute, the resulting feed rate of the workpiece is .001" per minute. Compound feed rates can be obtained by appropriate variations in the contour of the cam. Perfect smoothness and accurate control of Air Motor's piston rod is assured by use of a Bellows Hydro-Check.

807-C

THIS SPOT-A-MATION IDEA FILE IS YOURS ON REQUEST

Contains information on a variety of different parts feeders, as well as installation data, wiring diagrams and equipment lists for scores of other "Controlled-Air-Power" applications. Write for your free file . . . today! Address Dept. AU-960, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair

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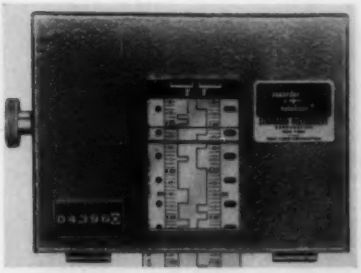
The Bellows Co. • Valvair Corp. *Akron 9, Ohio*

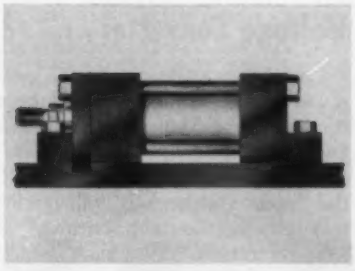
DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)



Time Recorder

Instrument is designed to graph *On-Off* time of any two processes on a single strip chart. This two-channel time recorder can be used to monitor production lines, plant systems, or individual machines. Applications include analysis of operation pattern of any machine, productivity comparison of two machines, and determining ratio of any operation function relative to any other. Feature of the unit is a built-in time totalizer, which furnishes a visual sum of productive time in hours and tenths, or minutes and tenths. A chronologically printed strip chart moves at a constant rate through the instrument. Two styli continuously scribe the tape, marking the *On-Off* operation of the machines to which they are wired. Standard chart roll speeds are 1, 4, 12, and 60 inches per hour. Slower charts run as long as 4 months without change. Recorder is available for either 110 or 220 v operation. **Standard Instrument Corp.**, 657 Broadway, New York 12, N. Y.

Circle 448 on Page 19



Power Cylinder

Unit features mounting that is designed not to shift and to eliminate bolting, pinning and/or welding of keys. It is created by providing side-mounted cylinders with

Stearns electro-magnetic DISC BRAKES

(THE CHOICE OF LEADING MOTOR MANUFACTURERS)

This Voss Leveler, installed at Inland Steel's Indiana Harbor Works—designed for hot-rolled plate up to 74-in. wide by 40-ft. long — from 3/16 to 1 1/2-in. thick . . . uses 4 of these Stearns motor-mounted, Style "H" Brakes.

. . . help this Voss Leveler flatten up to 1000 tons per turn — speeds to 282 fpm

Just as *Voss* solves almost any metals-leveling problem at high production speeds—with accuracy and flatness that in many cases equals or exceeds stretcher-level flatness . . . so *Stearns* has, for over 40 years, solved the problems of large, multiple disc Brakes (and Clutches) for the steel industry, cement industry, and other heavy-industry machinery . . . where their long, efficient life — ease of installation and maintenance have been *on-the-job-proved.*

For Superior Performance on ANY Machine . . . Specify Stearns!

For solutions to YOUR Brake and Clutch problems, call the Stearns Representative in your vicinity. Or write, stating your specific requirements, directly to . . .

BRAKES STEARNS ELECTRIC MILWAUKEE CLUTCHES

Stearns ELECTRIC CORPORATION
120 North Broadway, Milwaukee 2, Wis.
Phone: BRoadway 2-1100

THE COMPLETE LINE OF CLUTCHES . . . BRAKES . . . CLUTCH-BRAKES

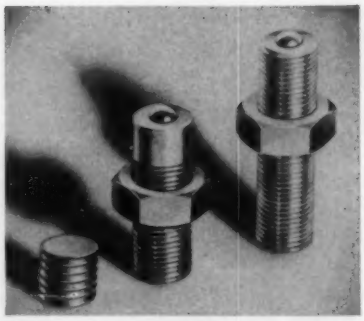
Circle 715 on Page 19

a flange plate ground to accurate thickness and extending beyond the mounting-side surface of the cylinder. Extension fits into slot milled into machine being powered. Cylinder mounting is especially useful for maximum load operation. It is available in styles 72 (side lug), 74 (flush side), and 77 (end lug) for all bore sizes of air and hydraulic cylinders offered by the manufacturer. **Miller Fluid Power Div., Flick-Reedy Corp.**, York and Thorndale Rds., Bensenville, Ill.

Circle 449 on Page 19

Air Jets

Units can be used to convert existing machines and worktables into air carrier units. They can augment existing conveyor systems, expand work areas around machines, and be applied in the beds of machines to reduce operator movement and strain. These air jets are available in three styles: Continuous air, ball type-press fit, and ball type-screw type. They can be used with high or low pressure systems, and with compressed



or free air. Free air pressure can vary from 1 to 7 psi, and high pressure from 12 to 30 psi. Load capacity of the units is up to 500 pounds. Balls seat tightly against valve head thus preventing leakage. Units are supplied with standard ½ by 27-inch thread. Jets can be mounted in steel, wood, masonite, formica, or plastic top tables. **Pedco Air Jet Div., Paper Equipment Distributing Co.**, P. O. Box 90, Prince Street Station, New York 12, N. Y.

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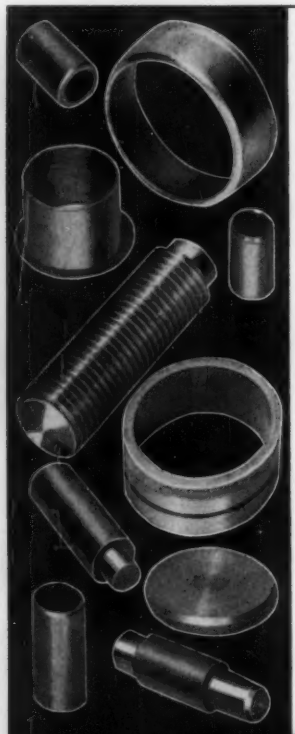


the Modern Way

TO CUT OFF AND FORM TUBING AND BAR STOCK *IN A SINGLE OPERATION*

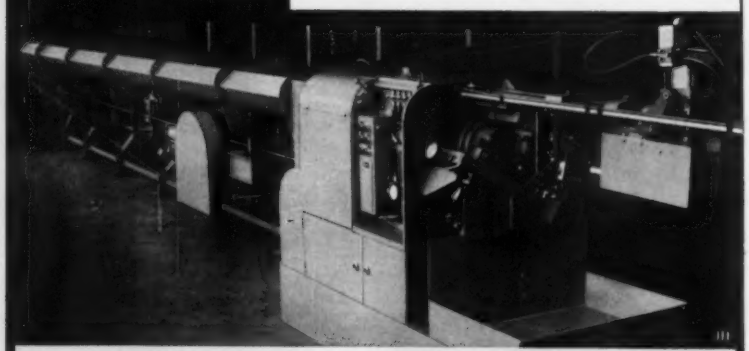
Here is a combination that feeds tubing and bar stock — automatically — to a fast, automatic cutting-off machine. Best of all, the pieces being cut off can be formed, grooved, flanged or chamfered at the same time.

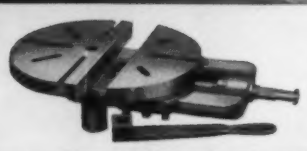
There are models that handle tubing, pipe and bar stock from ⅛" diameter up to solid bar stock of 3" OD and tubing up to 8" OD.

Why not investigate?

WRITE FOR CATALOG

MODERN MACHINE TOOL CO.
2005 Losey St. • Jackson, Michigan





FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

Voltage Converter

Completely static, solid state, precision analog voltage to frequency converter, the Magaverter produces an output square wave whose frequency is directly proportional to the input voltage. It will maintain an input-output linearity of ±¼ per cent. Eight standard models provide full scale output frequencies of from 30 cps to 25,000 cps. The maximum full scale frequency is adjustable over a 4/1 range with a built-in attenuator. Standard units provide for input voltage ranges of 0-1, 0-10, and 0-100 v. Model MI-1000-A will

No Other FEEDER Like It!

electro-permanent magnetic

ERIEZ

HI-VI VIBRATORY FEEDER

All-new award-winning feeder built on new concepts of design and materials. Provides accurate, controlled feed of bulk materials *automatically*. Variable feed rate, from ounces to tons. For spreading, sorting, aerating, cooling, proportioning, etc. Feeds all types of bulk materials. Increases production; reduces operating and maintenance cost.

NEW A.C. ELECTRO-PERMANENT MAGNETIC DRIVE PROVIDES GREATER FEEDING CAPACITY • NO RECTIFIER NEEDED • FULLY ENCLOSED POWER ELEMENT PROTECTED AGAINST DUST AND MOISTURE • RUGGED GLASS FIBER SPRINGS REDUCE BREAKAGE • FULLY PROVED IN PLANTS EVERYWHERE.

***ALSO AVAILABLE:** Economical, specially constructed units for hazardous, dusty locations . . . fully acceptable by Mill Mutual.*

WRITE FOR BIG VIBRATORY FACT FILE

Eriez Mfg. Co., 119-JB Magnet Dr., Erie, Pa.

ERIEZ

Circle 717 on Page 19

provide an output whose frequency can be set to vary linearly anywhere from 0 to 250 cps up to 0 to 1000 cps as the input signal is varied from 0 to 1 vdc. Device is readily adaptable to a variety of precision analog-to-digital conversion tasks. With a digital counter the converter serves as a digital voltmeter. For longer time periods the combination will act as a noise insensitive integrator giving a digital readout of flows, pressure, and volt seconds. Combined with a frequency to voltage converter, the voltage to frequency converter can be used to give a frequency output which is any desired multiple or fraction of the original frequency input. **Pioneer Magnetics Inc.**, 850 Pico Blvd., Santa Monica, Calif.

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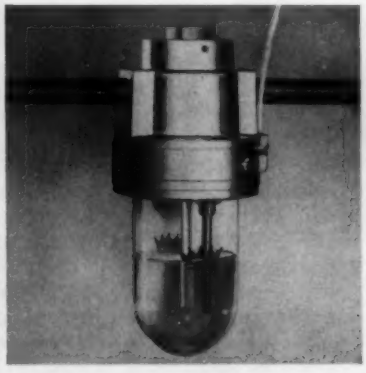


Lubrication Device

Unit has been designed for the lubrication of air operated devices. The system operates on pressure variations (pulses) and is independent of air flow rates and duration of flow periods. The outlet end of the oil delivery line may be placed in any location. Crown Pulse Lubricator provides positive lubrication of air operated equipment even when such equipment is located in high, overhead places and even when air flow through the lubricator is very low and/or infrequent. It delivers a metered amount of oil and controls the amount of oil feed from very rich (a drop every 3 or 4 pulses) to very lean (a drop every 100 or more pulses). **Hannifin Co.**, Dept. 142, Des Plaines, Ill.

Circle 452 on Page 19

FASTER SPEEDS, SHORTER LINES with MAGNETIC CONVEYING SYSTEMS

ERIEZ

permanent non-electric

ERIUM-POWERED* MAGNA-ROLLS

At this Westinghouse plant in Athens, Ga., cold rolled sheets are picked up by Eriez lifting magnets, and raised against Eriez Magna-Rolls which in turn feed them to a conveyor. This procedure eliminated a manual operation, and assures unvarying accuracy as well as dependable automated performance.

Get peak production with peak conveyor speeds. Powerful MAGNAMATION components positively hold, control, elevate, change direction flow of ferrous materials ranging from small parts to large sheets. Increase production . . . reduce production costs! For use both with and without belts on many types of conveying lines.

Completely non-electric • Easily installed on new or existing equipment • Low initial cost • No operating or maintenance costs • Various widths, strengths and contours to meet specific needs.

We work closely with design engineers, OEMs, etc. Contact us for assistance.

*Erium—*an exclusive, high quality permanent magnetic power source specifically designed and energized by Eriez.*

Send for free 56-page booklet

"Magnetic Ideas for Automation."

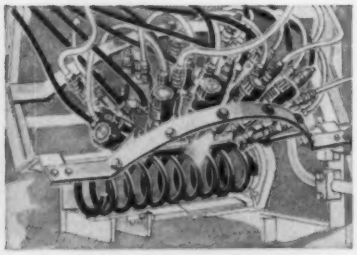
Eriez Mfg. Co., 119-JA, Magnet Drive, Erie, Pa.

ERIEZ

Circle 718 on Page 19

DeVilbiss spray guns apply almost anything that pours — automatically!

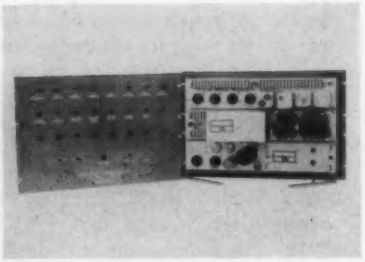
Automated color-coding



Equipped with 12 DeVilbiss automatic spray guns, this Electronic Spring Tester color-codes helical auto springs. Compressive stress absorbed by each spring is measured, then transmitted to an electronic selector, which actuates a specific gun for color-coding it. Spray cycle takes less than half a second! Investigate color-coding or other automatic applications with DeVilbiss spray guns. Contact our nearest representative. The DeVilbiss Company, Toledo 1, Ohio. Offices in principal cities.

FOR TOTAL SERVICE, CALL
DEVILBISS

Circle 719 on Page 19



Remote Control System

System can be used to control up to 256 functions. The Monitron solid-state control system also can be employed to monitor distant apparatus. For example, information about the status of a distant machine, such as whether it is running or standing; operating too fast or too slowly; at normal, too low or too high temperature; etc., can be continuously transmitted to the control point. The system coder unit and decoding unit may be interconnected by a pair of wires operating on a dc basis, or via a radio or telephone, or telegraph carrier circuit on a tone basis. A Monitron I coding unit is installed at the control point, and a Monitron II decoding unit is installed at the point where apparatus is to be controlled. By closing the contacts of an external switch at the control point a circuit is energized in the decoding unit and may be used to turn apparatus on or off. **Moore Associates Inc.**, 2600 Spring St., Redwood City, Calif.

Circle 453 on Page 19

Servomotor

Smallest in a line of Size 8 servomotors is designed to provide the high-torque and low rotor-inertia required for precise, rapid response to minimum control signals. It is 0.840 inch in length and weighs 1.1 ounces. Unit is wound for 115 v sources. Model 8 SM 461 has a rotor inertia of 0.18 gmcm^2 coupled with a stall torque of 0.22 oz in. providing acceleration at stall of 86,500 rad/sec^2. Use of stainless steel and Teflon as insulating material throughout enables the device to withstand an ambient temperature of −55C to +130C. Maximum unit operating temperature is 200C. **Helipot Div., Beckman Instruments Inc.**, 2500 Fullerton Rd., Fullerton, Calif.

Circle 454 on Page 19

Digital Readout

Miniaturized digital readout is designed for use with digital computers, control equipment, instruments, airborne equipment, production and inventory controls, and other electronic or electrical test equipment. It is possible to display words such as *Start, Stop, Fire, Destroy,* etc., as well as other information such as temperature, humidity, and pressure on the front viewing screen. In addition, red, orange, yellow, green, or blue colors may be displayed on the screen, either by themselves or as background for digits, words, or messages. The readout operates on a rear-projection principle. Unit contains a master condensing lens with 12 individual positions or lenses. On each lens is printed the desired digit, word, or message in the color desired. When one of the 12 lamps at the rear of the unit is lighted, the lamp projects the corresponding digit or color on the condensing lens through a projection lens onto the viewing screen at the front of the unit. The light source comes from subminiature lamps. Voltage is from 6 to 28 v. **Industrial Electronic Engineers Inc.**, 5528 Vineland Ave., North Hollywood, Calif.

Circle 455 on Page 19

Proximity Switch Control

Feature of proximity control unit is delayed relay action which can be obtained. When used with a proximity pickup, Model 4906-JIC provides a means of automating a variety of industrial processes. The proximity pickup, which is mounted at the point of work, senses both ferrous and nonferrous metal parts. Control provides two types of delay: Slow-make, quick-break and quick-make, slow-break. With the slow-make, quick-break type, metal can be in the presence of the proximity pickup for a given amount of time before the relay is energized. This type of delay, for example, is used for control of automatic parts feeders where it is desired to sense stack-up of parts in a feeder track. With the quick-make, slow-break type, the relay is energized immediately after the pickup is activated by a metal workpiece. This type is especially useful for control of fast-moving workpieces where movement is faster than normal relay operate time. **Electro Products Laboratories Inc.**, 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle 456 on Page 19

Bearing Units

Bearing units have been provided with contact seals that are comprised of three-part assemblies. Assembly presses on the ID of the out-

WHO cut out **WHAT** word from the dictionary?

im-pos"si-bil'i-ty, *n.* [-TIES, *pl.*] **1.** The fact or state of being impossible. **2.** That which is impossible; something that can not exist or be done.—**im-pos'si-bly**, *adv.*

THESE **are the men who cut it out:**

. . . part of the staff of Automation Engineering Laboratory, Incorporated . . . engineers, designers, inventors . . . yes, even dreamers. They have consistently solved "unsolvable" manufacturing, handling or processing problems . . . have designed and built "impossible" machines . . . that worked! They have done this for companies among the top five in such varied fields as Automotive, Electrical, Food, Paper, Textiles . . . etc.

Most important: in developing, designing and producing new or improved machines, processes and automated systems for industry, Automation Engineering Laboratory *has virtually eliminated costly risks of clients' capital!* How? By AEL's new concept of "STEP-BY-STEP Automation"®.

WHAT IS IT?

Briefly . . . it is AEL's systematic, step-by-step approach to creating equipment and processes. It involves *proving out* planned functions on working models . . . *one step at a time.* Function "A" is contracted for, completely proved out and demonstrated to you before Function "B" is even attempted . . . and so on. *Thus you will see your project operating in prototype within the first 15% of your total expenditure.* And, when your machine or system is completed, *it will work exactly as it should!* This is automation that any manufacturer can afford.

NOW...ABOUT YOUR PRESENT PROBLEMS

Whatever your automation problem, may we suggest you write or phone us? One of us will visit you . . . listen carefully to your problem . . . gather information. After studying your over-all layout, he will go back to Stamford and share your problem with other AEL Senior Staff Members. What he will then tell you is *"We can do it!"* and . . . on a contract basis you will appreciate.

Remember, the word "impossibility" has been cut out of our dictionary. Try us.

AUTOMATION ENGINEERING LABORATORY
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AEL Manufacturing Division, Inc.
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84 Commerce Road · Stamford, Connecticut

Circle 720 on Page 19

For accurate control of material flow — W-C CONSTANT-FEED WEIGH-HOPPER SYSTEMS

Wherever formulating or processing operations require highly accurate, uniform flow-rate control of dry, liquid or even hard-to-handle bulk materials, W-C Constant-Feed Weigh-Hopper Systems will do the job . . . continuously, automatically, economically.

Far more accurate than volumetric systems, W-C Constant-Feed Systems achieve precise control by continuously measuring the rate of material weight loss during discharge from a hopper (or tank), and regulating that discharge to maintain a linear rate of reduction.

Using pre-engineered, unitized components, W-C can provide a Constant-Feed System custom fitted to your particular applicational demands. The cost is reasonable because the components are standard . . . whether for Simplex, Duplex or Proportioning-Type Systems.

Typical applications include: Blending and proportional feed-rate control in such processes as solid rocket fuel formulation; dry or liquid detergent formulation, etc.

Write for new Bulletin 40

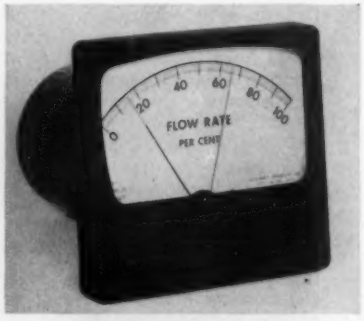
W&C WEIGHING & CONTROLS, INC.
Div. of CompuDyne Corp.

E. County Line Road • Hatboro 12, Pa.

Circle 721 on Page 19

er race. An inner flinger rides in close running clearance with the OD of the inner race. An outer flinger consists of a solid circular ring. These two flingers hold in position a Buna N coated fabric washer that has an interference fit on the OD of the inner race. The bearing units are available in pillow blocks and two (shown) or three bolt flange models for flush or recessed mountings. In all units unrestricted self-alignment, even after mounting, takes place automatically between the spherical OD of the bearing and the spherical ID of the housing. The bearings only are available with either a spherical OD (L) or a straight OD (SL) for special housing applications. The bearings and bearing units are available in the following shaft sizes: ¾, ⅞, 15/16, 1, 1⅛, 1 3/16, 1¼ inch (special), 1¼ inch (standard), 1 5/16, 1⅜, and 1 7/16 inch. **Sealmaster Bearing Div., Stephens-Adamson Mfg. Co.**, Ridgeway Ave., Aurora, Ill.

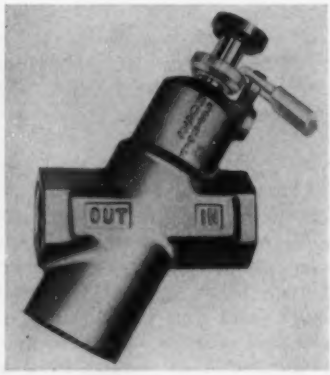
Circle 457 on Page 19



Reading Meter

Device combines a meter-relay movement and special circuitry to show the highest level reached by an electrical signal. Any variable that can be expressed as an electrical signal can be measured with this meter. A direct, unamplified signal is used in most cases. Until reset the adjustable pointer of the meter remains at the maximum signal reached over any period of time. The other pointer provides continuous signal indication. In operation, the adjustable pointer is set manually anywhere on the dial. The signal pointer then rises to the maximum reading pointer and kicks it upscale in very short bursts until the signal remains constant or declines. This action, at the rate of many times a second, is accomlished with special self-releasing circuitry that samples the signal. Unit is available in sensitivity ranges of 0-10 microamperes to 0-50 amperes, or 0-5 millivolts to 0-500 v ac or dc. Ac ranges above 50 amperes can be supplied by using an extra transformer. **Assembly Products Inc.**, Chesterland, Ohio.

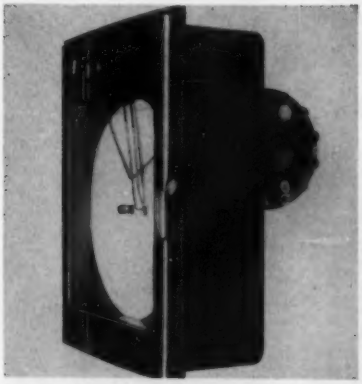
Circle 458 on Page 19



Air Valve

Unit is designed to increase safety during repair, maintenance, and shutdown periods on machines using compressed air power. It has only one moving part and is made in four sizes, for ⅜ to 1-inch pipe. The valve designated L-O-X (lockout and exhaust valve) is installed in the air supply line leading to the machine, upstream of any operating valve, and normally the air flow is right through it. When valve stem is shifted, air to the machine is shut off and the air downstream is exhausted to the atmosphere. The valve can then be locked in the closed position with a padlock. If a closed-center valve is used in the circuit, compressed air can be trapped downstream of it. Additional lockout and exhaust valves should be installed on each outlet port of the closed-center valve. Segments of air circuits can be isolated and inactivated with the new valve, thus making a portion of the machine more safely available for servicing. **Ross Operating Valve Co.**, 120 E. Golden Gate Ave., Detroit 3, Mich.

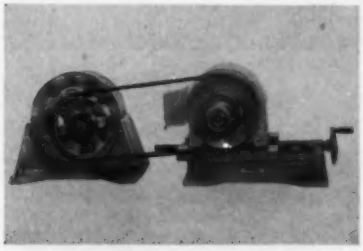
Circle 459 on Page 19



Bellows Flowmeter

Differential pressure measuring device can be used for both flow and liquid level applications. It is accurate within ½ of 1 per cent using no mercury, seal-pots, purges, or stuffing boxes. The meter body is self-draining and self-venting, and is rated at 2000 and 5000 psig in steel and stainless steel. Flowmeter has ranges from 0-20 to 0-300 inches of water and may be changed by a simple exchange of the range spring assemblies. This indicating and/or recording instrument can be equipped with a controller, totalizer, or with a pneumatic or electric transmitter. **Fischer & Porter Co.**, 471 Jacksonville Rd., Warminster, Pa.

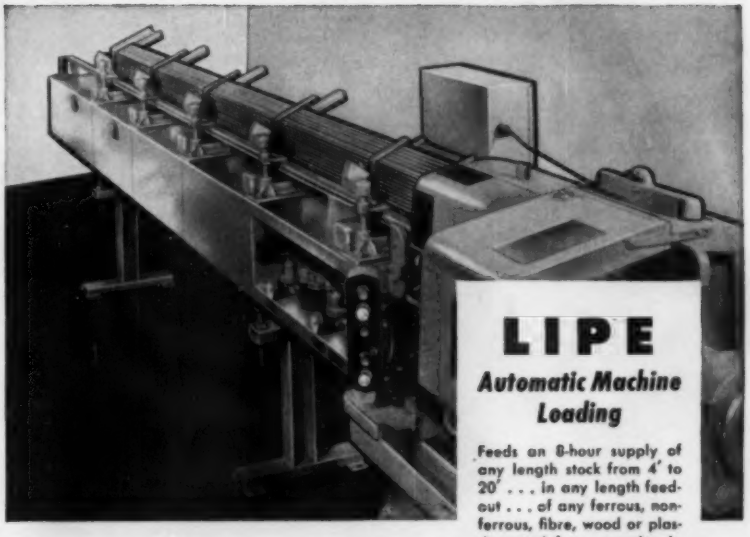
Circle 460 on Page 19



Variable Speed Drive

Unit is designed for use with ¾, 1, 1½, 2, and 3 hp motors. It combines standard variable speed pulley, belt, and adjustable motor base with a shaft-mounted or horizontal-base mounted helical geared reduction unit. Driven shaft speeds are provided in various 3 to 1 infinitely variable speed ranges between 431 and 24 rpm. **Boston Gear Works**, Quincy 71, Mass.

Circle 461 on Page 19


LIPE
Automatic Machine Loading
Feeds an 8-hour supply of any length stock from 4' to 20' . . . in any length feed-out . . . of any ferrous, non-ferrous, fibre, wood or plastic material . . . ranging in diameter from 1/16" to 1½".

Continuous Automatic Feed

of bars, rods, tubing in practically every shape used!

LIPE AML Bar Feeds will give you faster, finer production with less scrap and refinishing and a more efficient use of manpower.

They are applicable to a wide variety of machines, including single-spindle automatic screw machines, turret lathes, centerless grinders, abrasive-wheel cut-offs, punch presses, cold headers, die machines and others.

Sold and serviced by franchised distributors in principal industrial areas. Write or wire for complete information.

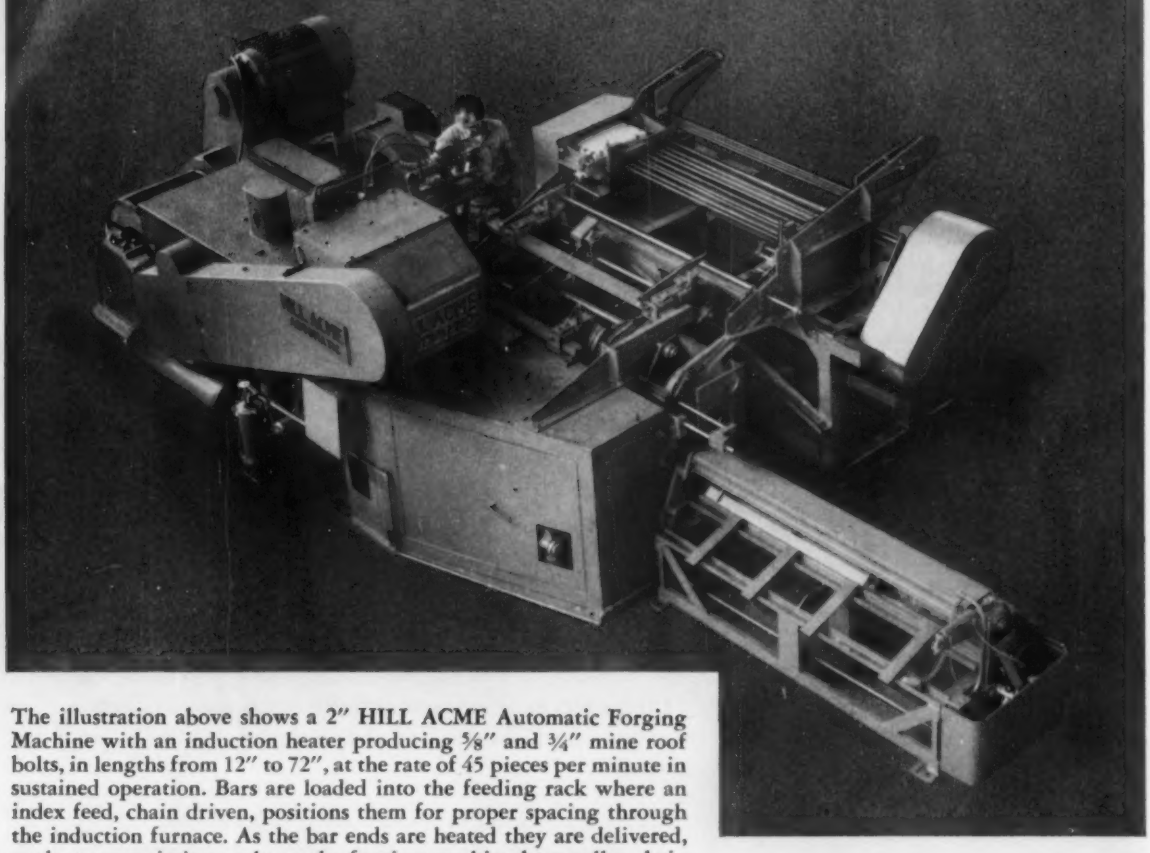
STOP CUTTING AIR AND YOU START CUTTING COSTS

LIPE ROLLWAY — Lipe-ROLLWAY CORPORATION, SYRACUSE 1, N.Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 722 on Page 19

Fully Automatic
FORGING MACHINE
DELIVERS 45 PIECES PER MINUTE!



The illustration above shows a 2" HILL ACME Automatic Forging Machine with an induction heater producing 5/8" and 3/4" mine roof bolts, in lengths from 12" to 72", at the rate of 45 pieces per minute in sustained operation. Bars are loaded into the feeding rack where an index feed, chain driven, positions them for proper spacing through the induction furnace. As the bar ends are heated they are delivered, at the proper timing cycle, to the forging machine by a roller chain feed where they are gauged for length, picked up by fingers and passed progressively through the dies. Finished forgings are discharged from the back of the machine by means of a separately driven conveyor, arranged for both right and left hand discharge.

The design of this new HILL ACME AUTOMATIC forging unit does not limit the number of passes or the length of stock to be used in forging a variety of parts. Pieces longer than 36" are supported by a walking beam through the various passes.

HILL ACME AUTOMATIC forging machines are built in 1¼" to 5" capacities all of which can be automated. Your inquiry concerning high speed automatic forging equipment will receive prompt attention.

The HILL ACME Company

1207 W. 65th STREET • CLEVELAND 2, OHIO

HILL ACME TOOLS FOR INDUSTRY

Manufacturers of: "ACME" FORGING • TAPPING MACHINES • "CANTON" ALLIGATOR SHEARS • ROTARY SHEARS • BAR-BILLET SHEARS • "HILL" GRINDING AND POLISHING MACHINES • HYDRAULIC SURFACE GRINDERS • "CLEVELAND" KNIVES • SHEAR BLADES • MATERIAL HANDLING EQUIPMENT

We now manufacture, distribute and service the entire line of KLING metal working tools.

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Latest automation information. For copies use card on page 19.

Fluid Flow Rate Alarms

Brooks Rotameter Co., Hatfield, Pa.—4 page pamphlet—Bulletin 175 contains data on a line of fluid flow rate alarms used for signalling or simple control functions. Details are given on a magnetic alarm for use with rotameters with extension type metering floats. Operating features and specifications of an electronic alarm for use wtih rotameters with glass metering tubes and unguided or ribguided metering floats handling under 1 gpm water or 1.6 cfm air are given.

Circle 462 on Page 19

Instruments and Controls

Instruments Inc., P. O. Box 556, Tulsa, Okla.—12 page booklet—Data are given in Catalog 4-60 on a variety of industrial instruments and controls. Continuous level and density controls, level switches, combustion controls, and various valves are described and illustrated. Availability of a capacitance level control in four basic models is noted. Notes are also given on float switches featuring magnetic latching devices.

Circle 463 on Page 19

Set Screw Driver

Standard Pressed Steel Co., Advertising Dept., Box 912, Jenkintown, Pa.—4 page pamphlet—Described in Bulletin 2302 is a set screw inserter, capable of 2500 insertions per hour. It can be used as an attachment to a single machine or as part of an automated production line. Horizontal, vertical, and 45-degree angle modes of operation are illustrated.

Circle 464 on Page 19

Gas Shield Metal-Arc Welding

Air Reduction Sales Co., Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, N. Y.—20 page booklet—Line of gas shielded metal-arc welding equipment is subject of Catalog 2350. Described in detail is the AH60-B manual gun for applications employing CO_2 as a shielding gas. Details are also given on two Aircomatic machine heads for production line welding. Accessory equipment covered includes a Fillerarc Rectifier power source, secondary contactors, and a line of flowmeter regulators for use with the welding processes. Welding wires, shielding gases, and gas delivery systems used are described.

Circle 465 on Page 19

Air and Vacuum Pumps

Leiman Bros. Inc., 102 Christie St., Newark 5, N. J.—32 page catalog—Rotary positive air pressure and high vacuum pumps, gas boosters and air motors are discussed in Catalog 460. Construction details, dimensions, capacities, application data, and performance curves on all pumps are provided. Types of pumps covered are two and four-vane, single and double cylinder, fan-cooled, oil-less, belt-driven, and direct-coupled. Full line of available accessories is explained and illustrated.

Circle 466 on Page 19

Variable Transformers

Superior Electric Co., Dept. HC, Bristol, Conn.—4 page pamphlet—Data are given on line of variable transformers in Powerstat H-C series Data Sheet No. 1. Operating principles of the transformers are explained. Pamphlet shows how reentry rings and helical coils permit extremely fine voltage adjustment with very low voltage drop, high current ratings, and high efficiency.

Circle 467 on Page 19

Multipoint Recorder

Industrial Div. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.—4 page pamphlet — Data on multipoint recorder, permitting change from two to 24 points within seconds, are provided by Bulletin S153-23. Various kits available for point, range, or actuation change are listed. Optional devices include operation pens, chart speed change gears, step-down transformer, and dual speed chart and print cycle drive.

Circle 468 on Page 19

Adjustable Speed Drives

Cleveland Machine Controls Inc., 1155 Brookpark Rd., Cleveland 9, Ohio—Two 8-page bulletins—Data are contained in these bulletins on sizes 1 and 2 of Series 35 line of electrical adjustable speed drives. Bulletin SL-351-460 describes size 1 for electrical drives up to ⅓ hp maximum, and Bulletin SL-352-560 describes size 2 for electrical drives up to ¾ hp maximum. Design and construction details, operational, installation and application information for each size are given.

Circle 469 on Page 19

Control Valves

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.—2 page pamphlet—Applications, features, and specifications on line of control valves are given in Bulletin 101. Features described include a choice of flange connections for every requirement, a "lift-out" seat ring, and position lip-seals for bubble-tight sealing. Accessories available are as follows: All-electric actuator, yoke-mounted pressure and temperature controllers, and a wide selection of trim materials.

Circle 470 on Page 19

Counting Devices

Pneumaticount Inc., 3400 N.E. 54th Ave., Portland 13, Oreg.—4 page pamphlet —Subject of this bulletin is automatic counting devices which are actuated by either pneumatic or hydraulic systems. Both pneumatic (15 to 150 psi) and hydraulic (150 to 10,000 psi) models are illustrated. Unit will handle up to 500 counts per minute and is available with five or six digits.

Circle 471 on Page 19

Timing Modules

Tempo Instrument Inc., Commercial St., P. O. Box 338, Hicksville, N. Y.—16 page booklet—Controlled solid state timing modules for precision timing control and logic applications are described in Bulletin 5906. Both fixed and adjustable types with time delays from 0.0005 to 300 sec-

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Circle 724 on Page 19

onds are covered. Accuracy ratings of 10, 5, or 3 per cent in fixed types, and 10 or 5 per cent in adjustable types are discussed. Descriptions are provided of the following: Circuit design, manufacturing and assembly process, sizes, weights, and terminal styles.

Circle 472 on Page 19

Data Processing Systems

Friden Inc., Promotion Planning Dept., 1 Leighton Ave., Rochester 2, N. Y.—28 page catalog—Line of automatically controlled data processing systems is described in Catalog SP-8604. Step-by-step illustrations and concise explanations of such diversified applications as letter writing, purchasing, manufacturing control, and bank check coding are given. Details are given on tape-operated machines such as the Flexowriter for document writing, the Computyper for invoicing, the Teledata for code transmission, the Collectadata for collecting work data, and the Selectadata, an auxiliary unit for data selection readout. Also described is the building-block concept utilized to provide various degrees of automation. Auxiliary units for this purpose are listed.

Circle 473 on Page 19

Moisture Monitor

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.—2 page pamphlet—Liquid process moisture monitor capable of continuously analyzing water concentration in organic-liquid systems is subject of Bulletin 26312. Method of packaging the monitor in two units, analyzer and control, is discussed as well as areas of application. A number of photographs are used to illustrate construction features of the instrument.

Circle 474 on Page 19

Creative Analysis for Wiring

AMP Inc., Harrisburg, Pa.—10 page bulletin—Method of creative analysis for better wiring is subject of Bulletin 4210. Operation details are given as well as typical application examples. Precise, precalibrated pressure feature of solderless termination technique is discussed.

Circle 475 on Page 19

Presses and Press Brakes

Verson Allsteel Press Co., 9300 S. Kenwood Ave., Chicago 19, Ill.—24 page catalog—Data on mechanical and hydraulic presses and press brakes, hydraulic shears, and press and brake tooling are contained in Catalog G-60. Specifications and model numbers are listed for each type of machine, and photographs illustrate the frame types available. Also discussed are special purpose presses and equipment.

Circle 476 on Page 19

Chain Belt Conveyor Furnaces

Electric Furnace Co., 600 W. Wilson St., Salem, Ohio—12 page booklet—Line of electrically heated and fuel fired continuous chain belt conveyor furnaces for clean and scale-free hardening, nondecarb hardening, carbon restoration, carburizing, carbonitriding, and other heat treatment of bolts, rivets, and bearing races is covered in Bulletin 601. Details on method of heating, forced circulation, and continuous conveyor quenching equipment used by the furnaces are included. Noted is the availability of the furnaces in 15 sizes with capacities from 175 to 3000 pounds.

Circle 477 on Page 19

Solid-State Circuits

Pennon Electronics Inc., 7500 S. Garfield Ave., Bell Gardens, Calif.—4 page pamphlet—Data are given in this brochure on a line of solid-state components. Specifications and illustrations are provided for power supplies and magnetic amplifiers. Ground support equipment, specialized solid-state equipment, and industrial control systems capabilites are discussed.

Circle 478 on Page 19

Automatic Machinery

Precision Detroit Co., 20100 Sherwood, Detroit 34, Mich.—46 page catalog—Line of automation components and assembly machines for use in industry is described and illustrated in Catalog 60. Included in this line are the following devices: Index tables, dial assembly presses, rivet spinners, special assembly machines, and automatic feeders.

Circle 479 on Page 19

Memory Core Tester

Digital Equipment Corp., Maynard, Mass.—4 page pamphlet—Data on memory core tester, designed for production line testing of ferrite magnetic memory cores, is contained in Bulletin F-2101. A block diagram of sensing and decision circuits, four different programs of current driving pulses, and examples of test and reject criteria are included in this bulletin.

Circle 480 on Page 19

Rotating Shaft Seals

Cartriseal Corp., 3515 W. Touhy Ave., Lincolnwood, Ill.—34 page catalog—Data are contained in Catalog 660 on a line of rotating shaft seals that are custom made. Models covered include O-ring, cartridge, labyrinth, grommet, boot, and metal bellows. Schematic diagrams accompany each model. Details and diagrams are also given on mating rotors.

Circle 481 on Page 19

Electronic Computer

Data Processing Div., Royal McBee Corp., Port Chester, N. Y.—8 page bulletin—Bulletin S-484 describes a case history of an electronic computer which was installed to handle the design of a refinery with multiple feed streams. Solving of oil refinery design problems from well head to storage tank is discussed. Method of obtaining twice the effective memory from the computer is explained.

Circle 482 on Page 19

Sound Control

Allied Witan Co. Inc., 12500 Bellaire Rd., Cleveland 35, Ohio—12 page booklet—Details are given in Catalog 609 on a method of noise prevention with mufflers. Illustrated are typical sound

control devices with graphs showing reduction of noise in decibels. Charts are given showing flow rates and operating specifications. Applications of the silencers and diffusers used on air motors and industrial equpment are described.

Circle 483 on Page 19

Fluid Meter Compensation

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—2 page pamphlet—Data on pressure-temperature compensation of fluid meters are contained in Bulletin 21. Principle of operation of the various systems employed is explained. Pneumatic and electric transmission systems used are discussed. Equipment comprising each system is listed, and schematic diagrams illustrate basic setups utilized by the systems.

Circle 484 on Page 19

Forming Equipment

Cyril Bath Co., 32322 Aurora Rd., Solon, Ohio—16 page booklet—Subject of this booklet are forming machines and systems. Radial draw, stretch, and compression forming machines are covered in detail. Actual parts produced by these machines are illustrated along with production tooling. A tension control system is illustrated.

Circle 485 on Page 19

Meters, Feeders, and Controls

B-I-F Industries, P. O. Box 1342, Providence 1, R. I.—8 page bulletin—Data on a line of meters, feeders, and controls are contained in Bulletin 0001.20-1. The following are included in the line: Butterfly valves, supervisory control systems, totalizing meters, water and waste treatment equipment and systems, flow meters, process instrumentation, feeders for solids and liquids, and blenders for liquids. Photographs are used to illustrate the various items discussed.

Circle 486 on Page 19

Variable Speed Drives

Zero-Max Co., 1952 Lyndale Ave. South, Minneapolis 5, Minn.—16 page booklet—Line of variable speed drives for fractional horsepower applications is covered in Catalog ZM-400C560. Typical applications are both listed and illustrated. Operating features and installation suggestions are accompanied by numerous diagrams and tips on power transmissions. Details on all types of units with or without motors are given. Charts and diagrams are used to answer possible questions on the use of mechanical variable speed drives.

Circle 487 on Page 19

Printing Scales

Toledo Scale, Div., Toledo Scale Corp., Toledo 12, Ohio—4 page pamphlet—Subject of Bulletin 2023 is line of printing scales. Models illustrated include portable, bench, and floor types. Selector disc for translating weight data originated in the dial mechanism into digital form is mentioned. Various choices of identificaton for recorded weights are given.

Circle 488 on Page 19

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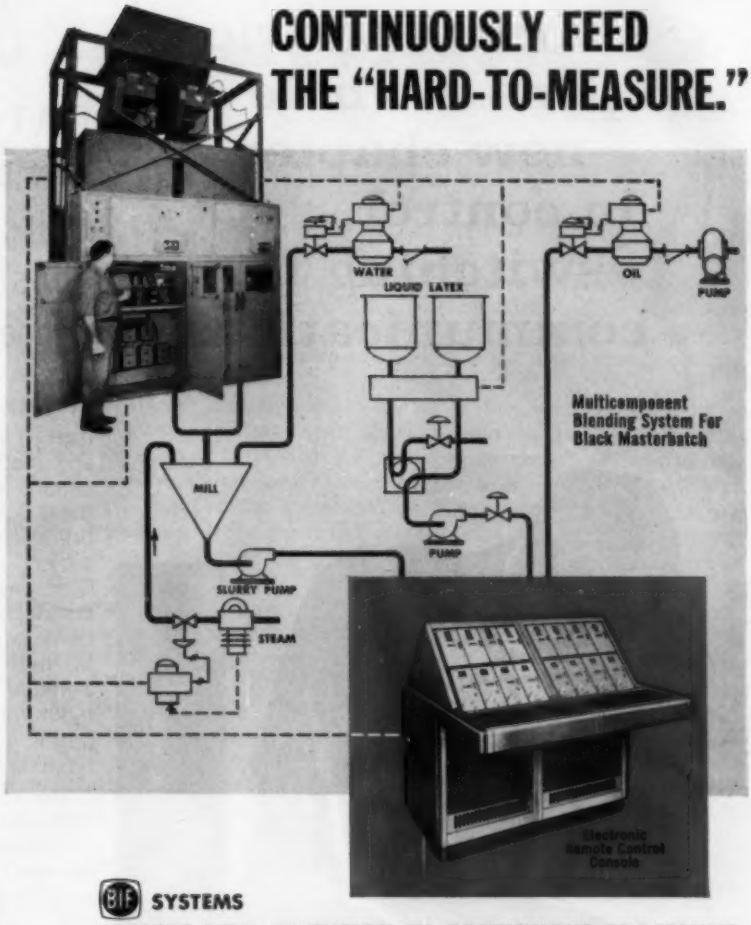

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Circle 725 on Page 19

North Electric opens a whole new chapter in control switching for communications

60-S-3

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new north solid state switching technique chosen for 412L air weapons control system

In awarding the contract for the design and manufacture of fixed and mobile electronic communications and switching centers for the U.S. Air Force, General Electric, prime contractor for the "412-L" project, selected North Electric Company, recognizing that a major technological breakthrough in electronic switching has been achieved by North with the development of a unique "Resonant Transfer" technique for generating or detecting pulses in Time Division Multiplex Solid State Switching!

The adoption of this North concept opens a whole new era in communications, a whole new chapter in the history of electronic switching!

It is highly significant that with this development the switching art has reached the state of sophistication demanded by new weapons capabilities. It is equally significant that this development should come from the Company whose history, over better than three-quarters of a century, has been one of continuous progress and development in this field!

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AUTOMATION abstracts

MEMORY TECHNIQUES

By S. ATHEY
Advisory Engineer
Ampex Research Div.
Ampex Corp.
Redwood City, Calif.

JOBS which recording will be able to take over in the future, once its potentialities and capabilities are more fully realized, are seemingly limitless. It is the purpose here, then, to review the state of the art as we presently know it and to show the magnitude of the field.

Any recording process involves the use of a recording medium which has characteristics making it possible to change some property of the medium in a simple way. Equally important, the induced change must be detectable in a stable and precise manner at a later time. Practical considerations also require that the production of the change (recording) and the detection of it (reproduction or playback) be accomplished at a fairly high speed. Particularly to those with a background in magnetic recording, the ability to erase the induced change so that the material may be reused seems to be another essential.

Magnetic Tape Recording

The characteristic property of the medium utilized here is the ferromagnetic nature of certain metallic compounds. The important thing about a ferromagnetic material is that when it has been placed in a magnetic field and the field is removed, the magnetism in the material does not disappear, but some so-called "remanent" magnetism is left behind. This remanent magnetism forms the record, and its presence may be detected by various means.

In the most widely used process for reproduction of magnetic recordings, the magnetic material or tape is moved past a magnetic reproduce head which is so arranged that the field in the tape produces a corresponding transient field in the reproduce head, and the change in this transient field is detected. A reproducing pick-up device may be made which is sensitive to the presence of the magnetic field rather than to the transient change therein.

When magnetic recording was first used, frequencies up to a few thousand cycles per second were all that needed to be recorded. We now have instrumentation recorders which record up to half a million cycles per second, or even higher, and a television unit which handles frequencies up to four and a fraction megacycles per second.

Limitations on bandwidth in present practical magnetic recording devices are imposed by the record and playback means used. With conventional techniques, a high relative speed between head and tape is necessary to achieve a wide bandwidth, and the 1500 inches per second effective scanning speed of the television machine seems to approach the upper useful mechanical limit.

High-speed switching of tiny multiple heads by an electron beam operating with a solid-state-switching device, and the phenomenon known as "domain-wall movement" are being considered for this use. One of the complications of work in this particular field is that most of the non-mechanical scanning techniques under study require different recording and playback methods.

A very promising method (useful only for reproduction) is that using the so-called "Faraday Effect" to read the information from the tape optically. The Faraday Effect is one in which the plane of polarization of a light beam passing through an optically transparent magnetic material is rotated in proportion to the magnetic field in the material. By observing the light beam through a "crossed" polarizer, so that no light passes through the polarizers in the absence of a field, the presence and intensity of the magnetic field in the material studied can be directly derived from the intensity of the light passing through it.

Photographic Recording

Photographic recording is probably the oldest practical means of recording which still has a very large bandwidth and storage capacity by today's standards. It has the capability of extremely high storage density and almost no upper limit on bandwidth. For almost every current use of magnetic recording, however, the feature of erasability is so important that its absence from conventional photographic methods seriously limits the application of these methods to the tasks which magnetic recording presently performs. The fact that conventional photographic methods require a developing process before the recording is available further restricts their usefulness.

Processes which are almost photographic, but which overcome some of the problems of this type of media, have recently been studied and several are in commercial use. One, the so-called "Chalkley Film," uses phosphotungstic acid to produce an image when exposed to light and needs no subsequent development. Another, called Kalvar film, is developed by heat. Unfortunately, both of these processes are incredibly slow by normal photographic standards.

A related process which is claimed not to be photo-

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- hydro jet descalers
- colloidal graphite spray systems
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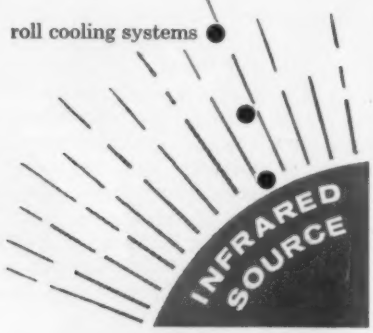

WHAT'S YOUR PROBLEM?

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graphic is that called "photochromic." This system uses a particular dye which has the property of being changed chemically from a form of one color to a form of another color in the presence of certain kinds of exciting radiation.

Electrical Polarization Recording

It seems reasonable that the ability of certain materials to hold electric charges might permit recording using electrical polarization. At least one electrostatic recorder resembling a tape machine has been demonstrated. There are three basic methods of recording through the use of stored charge. These might be described as straight electrostatic, electret, and ferroelectric recording.

The straight electrostatic process involves depositing an electric charge on an insulating material which has properties such that the charge will not drift sideways, but will stay where it is put without leaking off over a given period of time.

An electret system of recording has some attractive possibilities. An electret is a piece of insulating or dielectric material which has had a permanent charge placed on it, which charge cannot be removed without changing the physical form of the dielectric. A conceivable means of recording would be to apply a varying voltage containing the signal to a dielectric while it was in the stage at which it could receive the electret influence and then so processing the material that it passes into the permanent stage.

Ferroelectric materials were so named because they have properties analogous to some of the properties of ferromagnetic materials. These analogous properties may be described as the presence of an electrostatic hysteresis loop and of remanent polarization. The electrostatic hysteresis consists in that, as an increasing electric field is applied to a ferroelectric material, the resulting polarization or internal electric field increases with the applied field; but on reducing the applied field, the internal field does not fall to its original condition in the same way in which it arrived at its maximum value. If the electric field is applied and then turned off, a remanent polarization field will be found in the material.

Reproduction of data recorded on ferroelectric materials by passing them under electrical probes, such as a fine needle point, or by scanning an electron beam across them, has been successfully demonstrated. Ferroelectric recording appears to be fairly close to practical utilization at present. Because it lends itself to electron-beam recording and reproduction and because the ferroelectric materials appear to have no, as yet, discernible upper-frequency limit, it promises to be an excellent process for very-high-frequency work.

Electron Beam Recording

There is a large group of quite promising recording techniques which use different recording media but which can be classed together because they use electron beam read-in and readout and so lend themselves well to high-frequency recording.

One such method consists of using the energy of

the electron beam to distort a thin plastic. The distortion of the plastic can be detected optically in several ways, the most obvious of which employs the properties of many plastics of becoming somewhat optically active when mechanically distorted. Optically active means that the plane of polarization of polarized light is affected on passage through a distorted part of such plastic, and is differently affected when passing through a non-distorted plastic. This property is the basis for using studies of plastic models under polarized light for strain analysis of structures by the technique usually classified as "photoelasticity."

An electron-beam recording can be made on a magnetic material by a method called "Curie Point Recording." All ferromagnetic materials exhibit the phenomenon that the ferromagnetism disappears above a certain temperature called the Curie point. For recording, a thin film of magnetic material is magnetized perpendicular to the plane of the film and a heated point, or an electron beam, is passed over the surface so as to heat a small area to a temperature above the Curie point. Heating above this point effectively erases the initial magnetization and, when the small area cools down to a temperature at which it once again exhibits ferromagnetism, the effect of the adjacent magnetized areas is to magnetize it in the reverse of the original direction. The presence of the recording can be detected by the use of Faraday rotation or by another method called "electron mirror microscopy."

The process by which an electron beam "writes" on the front surface of a cathode-ray tube to produce a television picture or oscilloscope trace, represents a form of recording. Most phosphors so used have, however, a relatively short decay time and what recording there is, is spontaneously erased in a fraction of a second or a few seconds. A somewhat analogous process which uses materials called "Scotophors" can produce a visible record which may have a decay time of anything from several minutes to months.

Any electron-beam recording process must solve, before it is reduced to practice, the problem of producing an electron-beam record on a material in a vacuum. There are three ways of solving this problem: 1. Leave the record in the vacuum at all times. 2. Pull the recording medium from the outside air into the vacuum and out again through a series of airlocks and vacuum locks. 3. Produce the electron beam in a vacuum and allow it to pass through an electron-transparent window into the air-filled space containing the recording medium.

A practical electron-beam-recording system probably will combine elements of all three of these methods, the relative proportion of these elements and the complexity of the system being dependent on how difficult a recording job is being done and how bulky the equipment can be. A laboratory-type recording device could be put together today from existing techniques.

Non-Continuous Recording Media

In the discussion so far no mention has been made of non-continuous recording media, that is, recording not arranged continuously and sequentially along a

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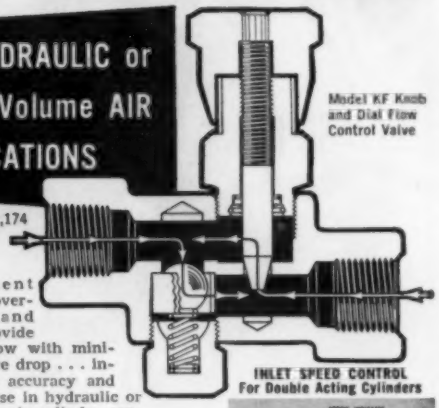
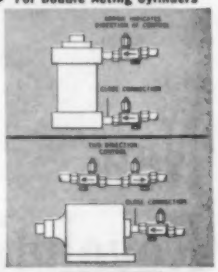
Patent #2,841,174



Model KF Knob and Dial Flow Control Valve

Auto-Ponent Valves with oversize ports and passages provide maximum flow with minimum pressure drop . . . insure greater accuracy and quick response in hydraulic or large volume air cylinder control. Self-aligning needle has unique Quad-Ring gland seal located at pressure port to seal off threads in needle housing, allowing needle to turn easily under maximum pressures. Gland structure and location also prevents air or dirt trapping in the housing. Flow Control and Check Valves have sensitive, chatterless ball check. Patented design insures rapid ball movement to open or close fully at low differentials. Made in 5 female Dryseal pipe sizes from ⅛" to ¾" inclusive. 3 Models: Standard, Knob and Dial, and Panel Mounting. Valve bodies are forged aluminum (3000 psi), steel or stainless steel (5000 psi). All internal parts are Stainless. Typical applications shown at right. Write for catalog AP59.

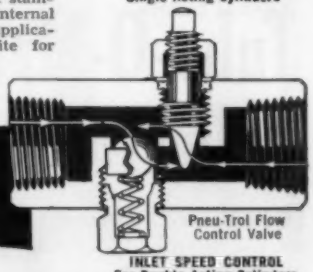
INLET SPEED CONTROL
For Double Acting Cylinders



SPEED CONTROL
Single Acting Cylinders

For AIR APPLICATIONS

Patent #2,811,174



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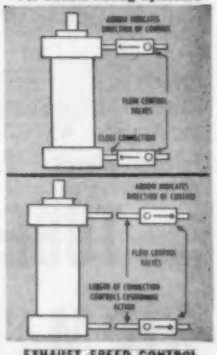

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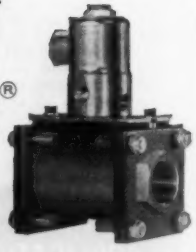

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AX-29

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medium of the class such as tape. Such recording devices are really discrete memory devices and many forms of them are used or proposed for use as memory elements in computers. Magnetic cores, shift registers, punched ferrite memories, superconducting memories, and many other possibilities are being considered. At present, applications of such memories and of tape do not overlap, discrete memories being useful for semi-fixed use in a computer with a rather sharp upper limit on memory capacity, and tapes being applied from the point where discrete memories run out of capacity up to the point of handling large masses of data at the input or output of the computer.

A possible marriage of the continuous and discrete memory can be imagined. Techniques which are suggested are those used with the electron microscope which has a resolving power in the order of 200 Angstrom units (one Angstrom unit is equal to about one millionth of an inch). The important implication of being able to look at information packed as densely as this is that the use of a piece of tape some inches wide and thousands of feet long in order to carry a particular collection of information would not be necessary, since the same information when packed to this high density could be fitted into an area of less than one square inch.

From a report "The Continuing Search for Advanced Memory Techniques," in Readout Special Report, Sept. 18, 1959, *published by Ampex Corp.*

EVALUATING EXTRA FEATURES

By F. SCHNEIDER
Assistant Comptroller
United Merchants and Manufacturers Inc.
New York, N. Y.

MANY of us are forced to consider various features and attachments at the time of purchase of basic equipment, meaning that a machine can be purchased with or without these features. For the purpose of the approaches to be discussed, integrated or incorporated features in a piece of equipment will be handled the same as if they were a basic piece of equipment which would have to be evaluated on its own. The only difference may be the depreciation rate used. In order to come up with the correct base for evaluating, these features should be added in separately, thus showing in detail the over-all project with all the features, as well as a stripped-down project, and of course the various stages in between.

Let us look at methods of amortizing these features. The most common method used is the repayment period, which we get by dividing the yearly savings by the original investment. This method, generally speaking, understates the savings that can be obtained, in addition to which it does not take into account the principle of cash flow.

Another method which is used to calculate the repayment period uses the average investment as differentiated from the original investment used in the first method. This method overstates the repayment period.

Something ***NEW*** *you should know about!*

FEEDMATIC-DETROIT AUTOMATED EQUIPMENT

Now, you can speed small parts production and cut costs with new Feedmatic electrically controlled machines. These units automatically and continuously feed, inspect, segregate or assemble parts at greater efficiency . . . reduce handling costs on high volume operations. Use Feedmatic automated machines separately or for high speed delivery to machine tools, heat treating furnaces or final assembly areas.

If your operation involves the manufacture or processing of parts in volume quantities, it will pay you to investigate the cost saving advantages of Feedmatic automated equipment. *Send us your problem today!*

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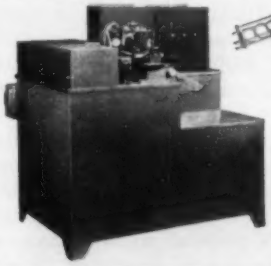
Automatic Gaging Machine measures and sorts parts. Adjustable stops, anvils and gage heads to facilitate change over to different size parts. Tolerance of electrical gages adjustable from .0005 to .020.



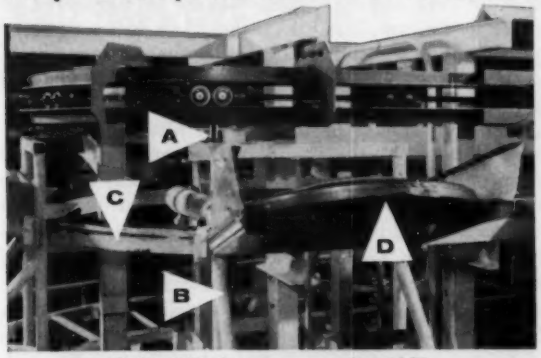
Model 12F Floor Hopper. Parts storage capacity, 12 cubic feet. For automatic feeding of larger parts.

Rotary hopper unit. Fast, efficient parts feeding. Available in sizes from 8" to 24". Feed tracks engineered to meet specific job conditions.

Special machine for automatically assembling automotive components.

AMERICAN "CHAINLESS" CONVEYOR

helps RCA produce color TV tubes



Trolley drive dog engages carrier at "A"
Carrier "B" rides on track "C"
Color TV tube shadow mask assembly in carrier rack "D"

Assembly line production of RCA color-picture-tube screens has increased yield of good screens and greatly increased operator productivity. Phosphor materials are automatically applied to RCA color tube faceplates, previously a hand operation. American "Chainless" indexing conveyor pushes carriers smoothly from station to station. Write for Catalog CD-B.

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Rounded Inner Bore for Faster Flow

Completely rounded inner bore (see arrow) provides entirely smooth radius —reduces turbulence, friction, heat and loss of pressure.

Male ends are tapered at shoulders to speed fluid flow through adjoining fitting—maintaining power delivery and efficiency of your hydraulic system. Proper use of Adapters reduces the number of threaded connections and opportunities for leaks.

WRITE for Technical Bulletin No. 500 on Adapters, Adapter Unions and Tube Fittings.

Eastman MANUFACTURING COMPANY
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Circle 730 on Page 19

Circle 731 on Page 19

AUTOMATION DEVICES'

MAÑANA??

NEW 'A' UNIT

with large lightweight bowl

DOES TOMORROW'S JOB TODAY!

In today's highly competitive market the "Never put off until tomorrow . . ." adage becomes increasingly important in costing modern industries' production. AUTOMATION DEVICES' engineering department had manufacturing costs in mind when they developed the new "A" series feeder. Created to do an exceptionally big job at a minimum of expense, an investment in this type of power unit and bowl combination is quickly self-liquidating. Increase your production all along the line with AUTOMATION DEVICES' parts feeders and get that job done today! Send for specific literature or new "Two Great Names in Parts Feeding" catalog.

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. . . TWO GREAT NAMES IN PARTS FEEDING

AUTOMATION DEVICES INC.

ERIE, PENNSYLVANIA

A third method, which is the best one, is the method which considers discounted cash flow. By that we mean that we try to amortize or repay only the investment which is actually outstanding from time to time over the life of a project.

Take the present worth of the investment. If all of the investing is done immediately, then of course the initial investment is the present worth. However, in some projects additional investments are made one or two or even three years after the project is initiated. Subsequent investments such as debugging, installation, possible expense of redesigning, and so on, should be calculated on the basis of their present worth.

Figuring Savings

The savings, too, should be calculated on the basis of present worth. If the projected period of activity for this equipment or its economic life is five years, and we get a first year return of say $100,000, then the present worth of that $100,000 will be considerably more if calculated over a period of five years. We are able, by the use of probability factors, to modify the return on the basis of risk for each of the economic-life periods.

All of these savings must be computed on their present worth, in order to use a common denominator, so that when they are added and summarized the resultant probability of achieving these savings can be taken into account. If a proposal involves changes in working capital or reductions in inventory, then the savings arising from those considerations should also be included. The reduction in working capital, which is mainly due to the reduction of inventories, is often one of the great advantages of installing integrated and automated material-handling features.

In many instances we are also asked to determine the per cent interest, which has to be considered in order to use capital on this rather than on an alternate project. The figure for calculating the appreciation of cash returned from an investment must not be the prime rate of interest, or even the hoped for rate. Actually, it should be the average historic rate of return of past projects. Therefore, if we get back $100,000 from our project each year and consider only the prime rate for this, then we will be doing our project an unnecessary injustice.

The savings associated with projects fall into three major areas. These areas consist of: 1. Direct and indirect labor. 2. Raw materials supplies and so forth. 3. Overhead, including the fixed and variable portions.

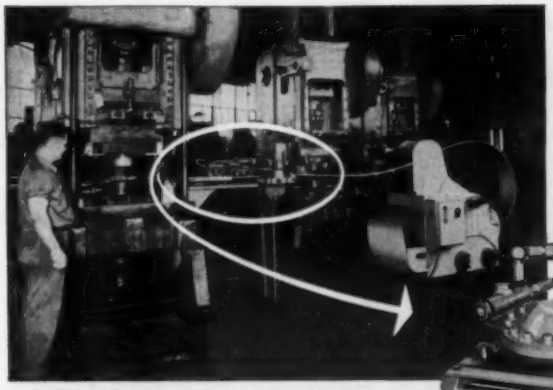
As far as direct and indirect labor are concerned, we have to measure the amount spent now, as compared to the amount that will be disbursed in our projected conditions. This will have to include overtime, makeup pay, and some other factors difficult to break out such as materials-handling labor, supervision, and even some factory clerical labor.

Under material we have to evaluate the waste made under one condition as compared to the waste made under the other set of conditions. In addition to this we have to consider related quality problems. Last but not least we have to consider savings that can be made in the design, or type of raw material used. In our

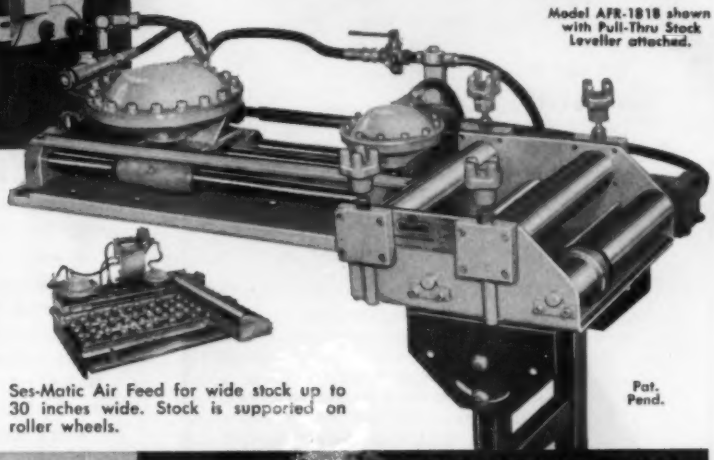
Ses-Matic AIR FEED

The Secret of Successful, Accurate Feeding of . . .

STEEL, ALUMINUM, PLASTIC, LEATHER, ETC.

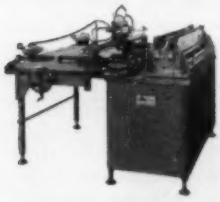


• The Ses-Matic "SPACE-SAVER" Line featuring the Ses-Matic Air Feed, Pull-Thru Stock Leveller and Coil Cradle.



Model AFR-1818 shown with Pull-Thru Stock Leveller attached.

Pat. Pend.



Ses-Matic Double Air Feed for materials up to 72 inches wide. This unit feeds stock 72" wide by .074 thick and removes coil bend with a Pull-Thru Leveller.

Ses-Matic Air Feed for wide stock up to 30 inches wide. Stock is supported on roller wheels.

Ses-Matic

Write for complete literature on all models of Ses-Matic Air Feeds and other Press Room Equipment.

SPECIAL ENGINEERING SERVICE, INC.

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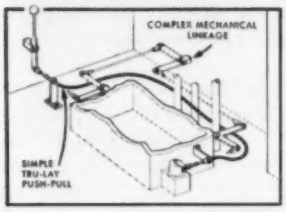
Circle 733 on Page 19

TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

Automotive and Aircraft Division

AMERICAN CHAIN & CABLE

ACCO

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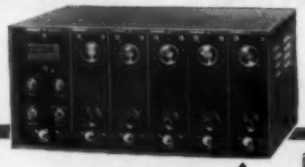
Circle 734 on Page 19

TALLY-COUNT®—*an electronic*

PREDETERMINING COUNTER

Standard 2-decade model:

$245.00



TALLY-COUNT is a versatile instrument, ideal for batch counting, packaging, unit flow and machine cycling. Tally-Count provides electronic speed and accuracy, at a price usually associated with electro-mechanical counters.

Plug-in decades (up to 5) $50 each

unique chassis design for plug-in sensing devices

A wide range of photoelectric and other sensing devices extends Tally-Count versatility. These devices plug into amplifiers, which can be incorporated as integral elements of the chassis. Tally-Count supplies all power for these sensing devices. No other power supply is needed.

Tally-Count operates accurately at speeds up to 100 per second. Batching capacity (5-decade model) is 100,000. Instantaneously resets to zero at desired count. Double and triple pre-set models available.

For full details, write for Brochure C-9.

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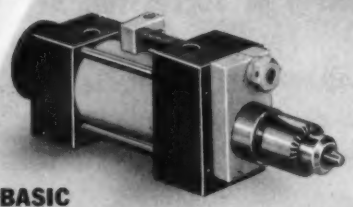
Circle 735 on Page 19

AUTOMATE
YOUR DRILLING OPERATION



BASIC AUTOMATIC DRILL
(1/4", 3/8" capacity)
$89.40

- Flexible automatic feed for drilling, tapping, reaming, milling
- Accurate depth adjustment of .0005"
- Fits into any setup
- 1½", 3", 6" strokes
- Ideal for single spindle, multi-spindle, and multi-plane machining
- Can be controlled by solenoid, hand or pilot valves

Alkon also manufactures compatible, 4-way valves and hydraulic cylinders.

For Free engineering assistance, call or write direct to

ALKON PRODUCTS CORPORATION
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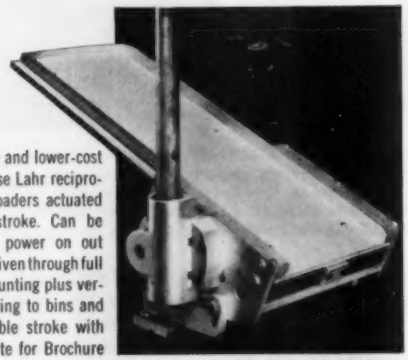
Circle 736 on Page 19

NEW
PART UNLOADERS REDUCE HANDLING



For fast, positive and lower-cost blank removal, use Lahr reciprocating chute unloaders actuated by your press stroke. Can be cable-timed (air power on out stroke) or rack-driven through full cycle. Simple mounting plus versatility of unloading to bins and conveyors. Variable stroke with gear change. Write for Brochure and Prices.

Model 20-59 shown

STANDARD MODELS AVAILABLE

Model No.	Tray Width	Tray Stroke	Power In	Power Out
20-RR-59	10" to 36"	10" to 20"	Rack	Rack
20-CT-59	10" to 36"	10" to 30"	Cable	AirCycle
30-RR-59	10" to 72"	12" to 30"	Rack	Rack
30-CT-59	10" to 72"	12" to 30"	Cable	AirCycle

Special tray widths and strokes available

Lahr MACHINE & TOOL CORP.
3404 Maplewood Ave. — Toledo 10, Ohio

Circle 737 on Page 19

industry for instance, one machine can use a cheaper fiber than another one.

Overhead of course includes fixed and variable overhead. Basically, the only fixed overhead is the cost to possess, and most of us only include depreciation in that. Other so-called fixed overhead items, which are affected by installation of materials-handling equipment and devices as well as by the installation of a complete equipment, are clerical labor, general maintenance labor, management quality control, and other features which vary with operation of a piece of machinery.

Flexible Budgets

All of these factors lend themselves very easily and readily for measurement by a device known as the flexible budget. These flexible budgets are the natural outgrowth of a standard cost system. A flexible budget is nothing more than a budget which can be set at any level of activity by the application of standard costs per unit of output. Briefly, therefore, if we are allowed $1.00 per unit or $100 per 100 units, and if the output were to be increased to 150 units, then our allowance would be $150.

Based on the flexible budget we know what our labor variances are, whether they be direct or indirect for every hour, week, or month. Also by use of the flexible budget we can determine what our overhead rates are and how efficiently our equipment is used. For instance, idle equipment will show unabsorbed overhead. Even material usage considerations, and variations in inventory levels can be highlighted.

With reports on labor, materials, and overhead, we can determine what savings have been achieved. Obviously, the difference between the previous and the present performance should be the savings ascribed to the improvement that we have made in the particular process. It is not important who audits these savings, whether it be accounting, manufacturing, or engineering. However, it is very important that these savings be audited over a long period of time. Many problems, if not followed up, will cause anticipated savings not to be realized.

Having been on both sides of the fence, I recommend that the followup of this nature be made a joint venture. Let cost accounting pinpoint the variances, let the engineering group follow up these variances together with manufacturing to see what can be done to further reduce or eliminate them. Variances referred to at this point are the variances in savings from the proposed or standard plan of operations.

All projects should and must be followed up until such time as the forecast savings have either been obtained or until all efforts to realize them have been exhausted. If the forecast savings have been obtained, then, of course, we have no problems. But if for some reason or other these savings have not been obtained, then these factors should be tabulated and considered a lesson in the evaluation of future projects.

From a paper entitled "Amortization and Determination of Savings of Material-Handling Features," presented at the annual meeting of the American Society of Mechanical Engineers, Atlantic City, N. J., December, 1959.

precision indexing to ±0.001"

. . . WITH GEM-17 DIAL INDEX TABLE!

FAST Geneva motion smoothly positions in speeds up to ½ sec.

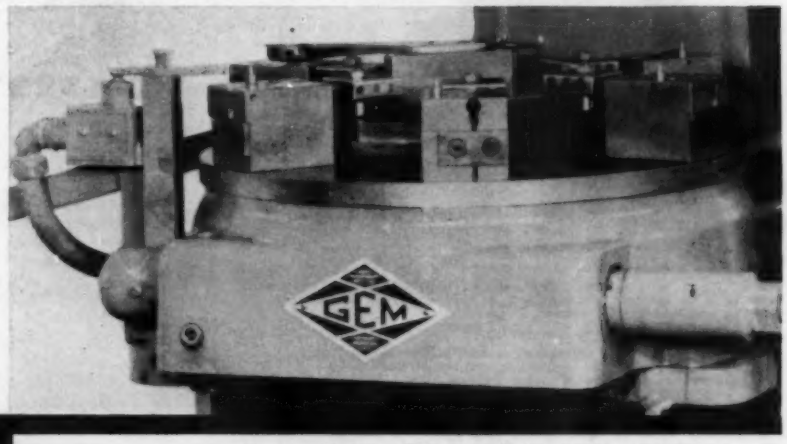
RUGGED 1000 lb. work load with solid anvil capacity of 30 tons.

POSITIVE LOCK Bolt in Geneva slot cammed both in and out given positive locking.

POWER Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).

NUMBER OF STATIONS 6, 8 or 12 standard, 3 and 4 skip.

SIZE AND WEIGHT 200 lbs. complete with 17" dia. table (plates up to 36" available).



GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.

Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

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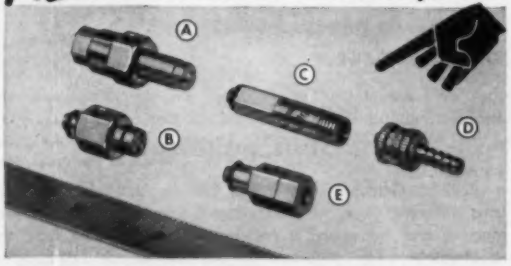
Circle 738 on Page 19

NEW MIDGETS for MAN-SIZED air-oil Flow Control jobs!



Ⓐ **MINIATURE FLOW CONTROL** — Operates on 1 lb. differential. Limited check one direction — full flow other. Recommended working range 0-250 psi. Air flow rate 3.6 CFM at 50 psi.

Ⓑ **MINIATURE NEEDLE VALVE** Precise control of air-oil in either direction. Range 0-2000 psi.

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Circle 739 on Page 19

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We are able to start machine design by processing your product in our Application Laboratory. Such studies guide our Engineering Department in developing equipment to be produced in our own Machine Shop. Let our specialists help you with your modernization program. Write today.

MACHINE DIVISION of FULLER BRUSH

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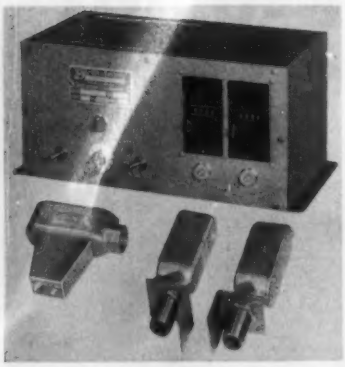
Circle 740 on Page 19



NEW ELECTRONIC COUNTER CONTROLS

Announcing 7 new, compact, packaged Pre-determining and Totalizing Counter units designed for accuracy and durability to fit 90% of the counting requirements of modern industry.

Various models incorporate features for:

1. Selective load relay operation at two different count outs. Relay contacts pulse only, or hold, during count out.
2. Counters pulsed directly from rugged amplifier tubes—no relay employed.
3. Counter relay pulsed—no tubes—no transistor circuit.
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5. Machine stops if light source fails—prevents production of uncounted units.
6. Miniaturized reflection or penetration scanning heads.
7. Counting speeds up to 1500 per minute.

Write for Counter Engineering Bulletin #960C. Submit details of your counting problem without obligation for recommendation and quotation.

Literature available on special application Photo-Electric and Electronic Automation Controls for all industries.

1. Double Sheet Detection and Gaging Control for ferrous metal.
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4. Special applications engineered.

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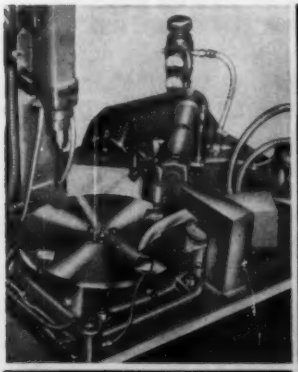

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AU-9

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are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2174-P

TEST PART PREPARATION

. . . We are producers of high alloy, high-speed, and specialty steels of all types. To inspect the internal soundness of our steel, we must cut "discs" from the ends of billets, bars of all shapes, and coils, etc. One side of each disc is then ground and subsequently polished to a very high finish for our inspection purposes. The polished surface must be reasonably flat but does not need be parallel with the opposite surface. The structure of the metal must not be disturbed in any way during the processing. Discs are approximately ¼ to ½ inch in thickness, and vary from ¼ inch diameter to 6 inches square. Approximately 1000 discs require processing each day. We now grind one side of each disc on a Besly disc grinder and manually polish them on a felt wheel with the aid of a buffing compound flowing on the wheel. I would welcome any ideas as to how I can take these discs "as received" and automatically process them to get a finished polished disc . . .

General Superintendent

SUGGESTIONS FOR 2172-P (AUG. 1960)

THICKNESS GAGE

. . . We are contacting the plant superintendent with the problem, giving him information on our equipment . . .

L. Earl Slusher
Industrial Nucleonics Corp.

. . . The General Electric Co. has, in the past, produced two different gages for measuring the thickness of non-conductive and non-metallic coatings on metal. The first was a Magnetic Gage produced by our Instrument Dept., West Lynn, Mass.; the second was a Backscatter Gage using a radioactive isotope. The latter gage was for very thin coatings. The former was for ordinary paints and enamels of the usual thickness. Information on the Magnetic Gage can be obtained from Mr. H. Day, Instrument Dept., West Lynn, Mass. Information on the Backscatter Gage can be obtained from Mr. S. Bernstein, X-Ray Dept., Milwaukee, Wis.

Dr. E. D. Cook
General Electric Co.

SUGGESTION FOR 2023-P (JUNE 1960)

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. . . We are enclosing data on our radiation temperature controller which has been used quite successfully in the manufacture of transistors, holding temperatures to a very precise limit. If this fits in with the manufacturing problem, we shall be happy to work with you upon its application . . .

A. C. Mason
Mason Instrument Co.

Circle 742 on Page 19

Yes...

YOU CAN CUT WINDING COSTS WITH

Patents Granted and Pending

AUTOMATIC FORT WAYNE STATOR WINDER

WRITE FOR COMPLETE DATA OR ARRANGE TO VISIT OUR PLANT FOR DEMONSTRATION

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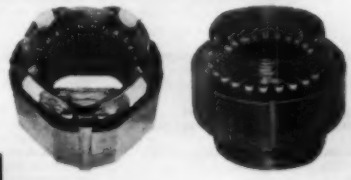
Automatic simultaneous winding of 2 to 5 group concentric coils . . .



*LOWEST MACHINE INVESTMENT PER UNIT PRODUCED.

- Winding speed at 325 RPM
- Preparation time: 4-pole, ¼ minute; 2-pole, ¾ minute.
- One operator can readily tend two or more machines.
- Automatic cutting and anchoring of leads.
- Winds greater range of stator lengths.

* Production example: 4-pole stator with 3-group concentric coil per pole at 125 turns per coil produces 88 stators per hour; 2-pole with 5-group concentric coil per pole at 159 turns produces 58 stators per hour.

Circle 743 on Page 19

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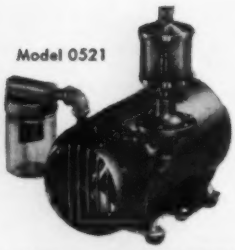

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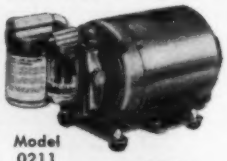

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Circle 745 on Page 19

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THE CAPITAL BUDGETING DECISION

By Harold Bierman, Jr., associate professor of accounting, and Seymour Smidt, associate professor of managerial economics, Graduate School of Business and Public Administration, Cornell University; published by Macmillan Co., New York; available from AUTOMATION; $6.00.

The authors advocate that discounted cash flow methods are superior techniques in evaluating investment opportunities. In particular, they recommend the "present value" method for ranking alternative proposals. The book, then, concerns itself with describing various techniques for measuring investment worth, comparing these techniques to the present value method, and explaining the use of the present value method in relation to the various complicating factors normally considered in reaching budgeting decisions.

X-RAY SPECTROCHEMICAL ANALYSIS

By L. S. Birks, U. S. Naval Research Laboratory, Washington, D. C.; 137 pages, 6 by 9 inches, published by Interscience Publishers Inc., New York; available from AUTOMATION; $5.75.

This is volume 11 of a series entitled "Chemical Analysis." The author proceeds from a review of fundamentals, theory, and equipment to the practical aspects of fluorescent x-ray spectroscopy. Included is a chapter that discusses 12 groups of applications to illustrate the problems for which this analytical technique is suited.

THE RELAY GUIDE

Edited by R. N. Auger; 383 pages, 8¼ by 11 inches, published by Reinhold Publishing Corp., New York; available from AUTOMATION; $10.00.

This is a compendium of electromechanical relays marketed in the United States. In preparing the listings, information concerning approximately 1000 relays has been gathered from company literature and catalogs and presented in a relatively standardized format.

Government Publication

Research and Development of the Magnacard System. *Report* PB 151828 *by A. M. Nelson, Magnavox Co., for Wright Air Development Center, 187 pages, available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.;* $3.00.

Development and features of information system using magnetic cards are described. Unit document concept is combined with high information storage densities and input/output rates of magnetic tapes and drums. Rates of 100,000 digits per second are described for 1 by 3-inch cards. Automatic files store 300,000 cards and provide automatic access.

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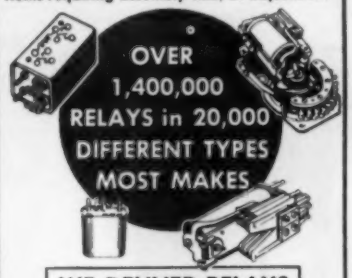

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Circle 747 on Page 19

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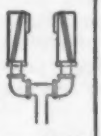
E8A-E8AP Remote heads with special mounting bracket



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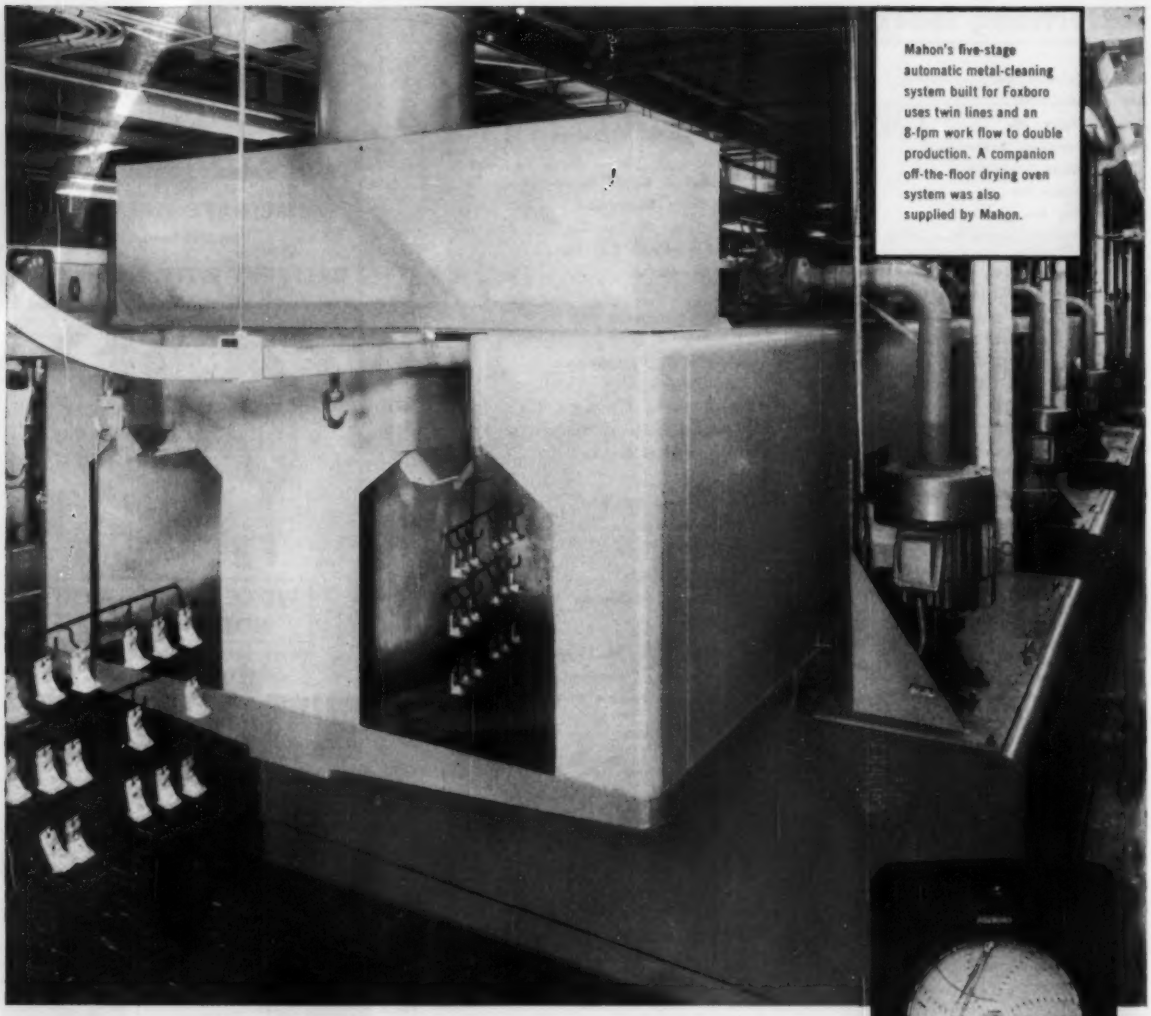

Mahon's five-stage automatic metal-cleaning system built for Foxboro uses twin lines and an 8-fpm work flow to double production. A companion off-the-floor drying oven system was also supplied by Mahon.

FOXBORO FINISHES INSTRUMENT CASES...AND 20,000 OTHER PARTS AS WELL...WITH MAHON EQUIPMENT

The Foxboro Company of Foxboro, Mass. is meeting the stepped-up industrial need for control and measuring instruments. Two new Mahon Finishing Systems and other allied equipment were recently installed to help solve Foxboro's accelerated production problems for these high-quality, high-precision products. The result: an automatic metal-cleaning process, flexible enough to handle some 20,000 parts—efficient enough to double capacity; and a space-conserving off-the-floor drying-oven system that integrates all priming and finish painting. The Mahon-engineered and built equipment not only met new production requirements under improved working conditions but also offered color flexibility (six of more than 150 colors can be run at one time).

Improved finishing is probably the *easiest . . . and most economical . . . product improvement* you can make. Call in a Mahon engineer and get the facts on what Mahon can do for your product . . . your costs.

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MAHON

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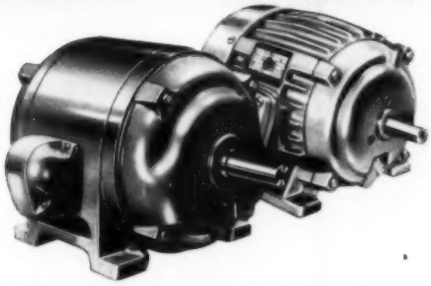
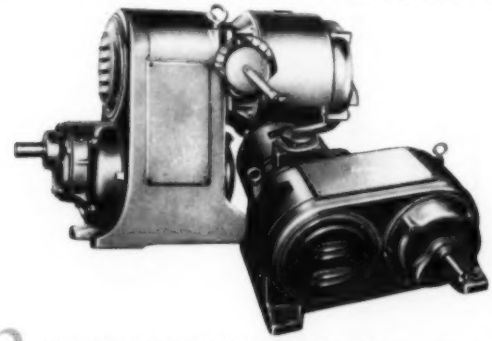
Which U.S. MOTOR will solve your problem?

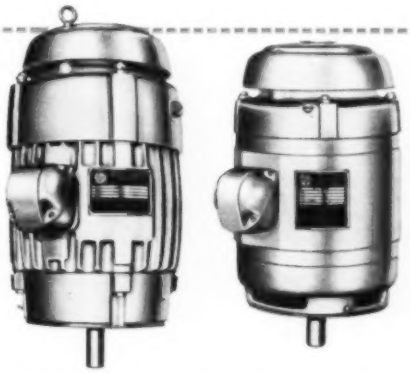


1 **HORIZONTAL MOTORS,** *Uniclosed,* dripproof, ½ to 250 h.p.; *Totally Enclosed,* 1 to 150 h.p.; *Explosion-Proof,* 1 to 150 h.p. (Other available types not shown)

2 **INTERNALLY GEARED MOTORS,** *Syncrogear,* ⅓ to 30 h.p.; *Syncrogear Right-Angle* worm-gear, ½ to 2 h.p. (Other available types not shown)



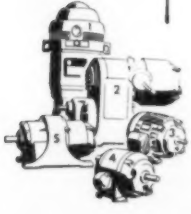
3 **VARIABLE SPEED MOTORS,** *Varidrive,* upright, ¼ to 75 h.p.; *Varidrive,* horizontal, ¼ to 60 h.p. (Other available types not shown)



4 **VERTICAL MOTORS,** *Unimount* vertical solid shaft, ½ to 500 h.p.; *Unimount Totally-Enclosed,* ½ to 150 h.p.; *Unimount Explosion-Proof,* ½ to 150 h.p. (Other available types not shown)

U.S. makes many types of motors... *for many uses in many industries*

There are U.S. MOTORS specialized to serve virtually all fields of industry. The above are just a few of them. Whatever your application, chances are that there's a standard U.S. MOTOR designed to fit it—for U.S. has been meeting specialized industrial needs for over half a century. The quality that is built into each U.S. MOTOR *at every point* is your assurance of long, trouble-free operation. U.S. offers, too, packaged systems of automatic speed control based on U.S. VARITROL or other automatic controls. U.S. VARIDYNE POWER PACK converts any standard AC fixed-speed motor to adjustable speeds. Besides motors and controls, U.S. furnishes power drives both for separate-mounted motors and for non-electrical applications. If you need motors...automatic controls...geared or belted drives...write or phone.



U.S. MAJOR MOTOR LINES INCLUDE:
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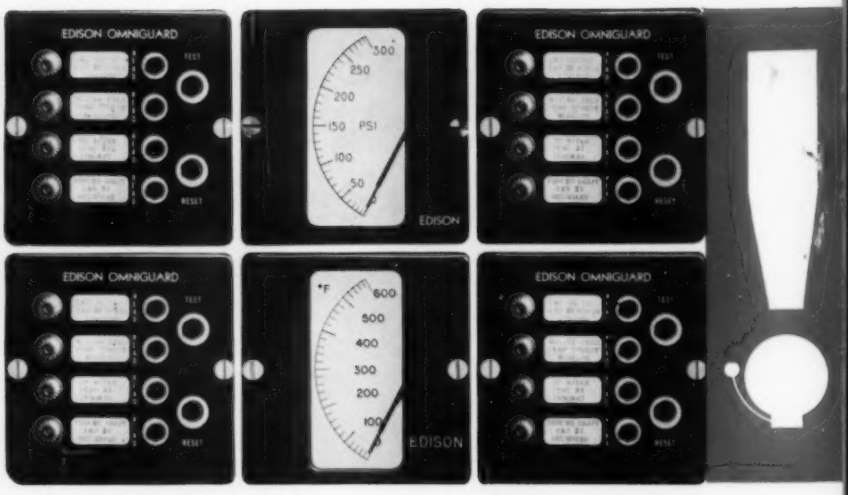
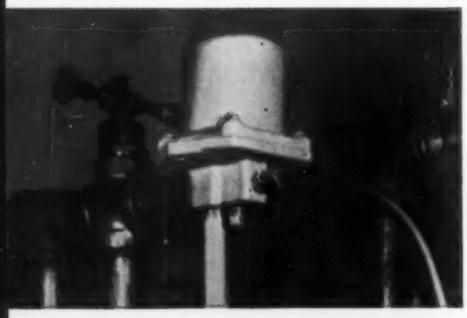
Circle 652 on Page 19

GUARD ALL CRITICAL PRESSURES AND TEMPERATURES WITH THOMAS A. EDISON LOW-COST, OMNIGUARD WARNING SYSTEM



Here is a versatile, highly-reliable continuous warning and monitoring system. By simply pushing a button on this panel you obtain a reading of *key pressure* and *temperature* points throughout your plant. In addition, this system provides instantaneous warning when pressure or temperature deviates from pre-set limits.

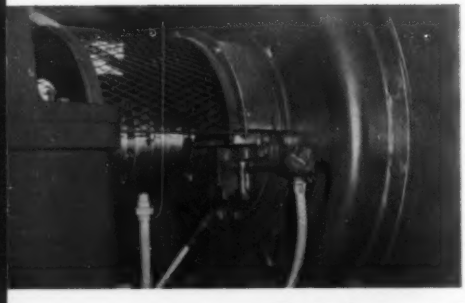


PRESSURE

With the Edison Omniguard system you can monitor gas, fluid or vapor pressure. Heart of the system is a rugged, accurate, pressure detector which converts pressure directly to electrical resistance—requires no millivolt conversion—no amplifier. For pressures under 60 PSI a precision capsule is the sensing element. From 60 to 3000 PSI special bourdon tube elements are used.

When pressure changes, resistance varies and this deviation is transmitted to the control panel. Units operate over ambient temperatures of 32° to 150°F. Control panels are available with a wide variety of scales and are equipped with both normally open and normally closed alarm contacts to operate any type of auxiliary device or to automatically shut down machinery or process.

Compact, reliable Resistance Pressure Detector transmits changes in pressure to central control panel.



TEMPERATURE

Edison Omniguard also provides reliable protection from overheating. You can monitor the temperature of bearings, gases and liquids in critical equipments or processes. Reliable Edison Resistance Temperature Detectors have no moving parts and give instantaneous warning when limits are exceeded. Unlike other systems which only scan, Omniguard is continuously monitoring. You can obtain exact readings of temperatures in all parts of your plant from one central control panel.

For greater flexibility and reliability each detector circuit is completely independent. If one circuit is damaged, all other circuits remain "on guard." When changes or additions are required they can be accomplished quickly and easily.

Rugged, accurate Resistance Temperature Detector guards against overheating of this motor bearing.

Thomas A. Edison Industries
INSTRUMENT DIVISION
86 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

Circle 653 on Page 19